

**REBUILD
BY
DESIGN**

LIVING BREAKWATERS

**IP EDITION
STATEN ISLAND AND RARITAN BAY**

**SCAPE / LANDSCAPE
ARCHITECTURE PLLC**

PARSONS BRINCKERHOFF
STEVENS INSTITUTE OF TECHNOLOGY
OCEAN AND COASTAL CONSULTANTS
SEARC CONSULTING
THE NEW YORK HARBOR SCHOOL
LOT-EK
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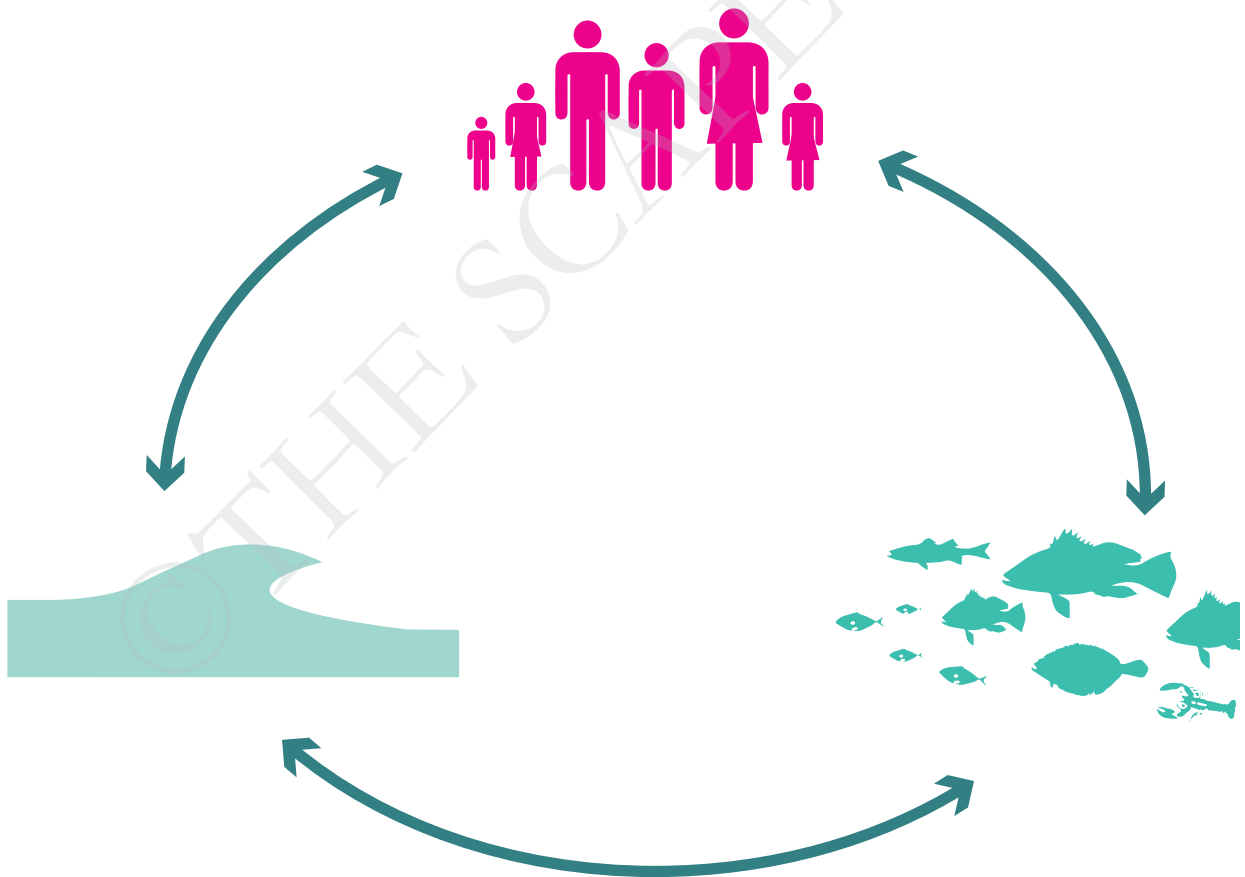
NATURAL RESOURCES PROTECTIVE ASSOCIATION

ZONE A NY

NY/NJ AUDUBON

KAYAK STATEN ISLAND

The SCAPE team has developed a science-driven methodology that pairs layered eco-infrastructural systems sited for risk-reduction with social and educational networks, rebuilding water based infrastructures in tandem with surrounding communities.



LIVING BREAKWATERS ON STATEN ISLAND



HABITAT BREAKWATERS

+ WAVE ATTENUATION

FLUPSY TANKS + OYSTER GARDENS

+ OYSTER GARDENS DISTRIBUTE SPAT TO REEFS IN THE SURROUNDING AREA, WHILE PROVIDING HANDS-ON COMMUNITY CONNECTIONS TO COASTING FOR AND LEARNING ABOUT MARINE ORGANISMS.

+ HERON HOOKERY

+ CONCRETE UNITS

+ MARINE MOLLUSCS

+ SPAT

+ SPAT MIGRATION

+ CONSTRUCTED TIDEPOLLS PROVIDE SHELTERED SPACES FOR SMALLER INVERTEBRATES AND IMMATURE FISH TO THRIVE. PLACED IN THE INTERTIDAL ZONE, WATER IS FLUSHED THROUGH THE BOTTOM OF THE STRUCTURE.

WATER CIRCULATION

ECONCRETE CONSTRUCTED TIDEPOLLS

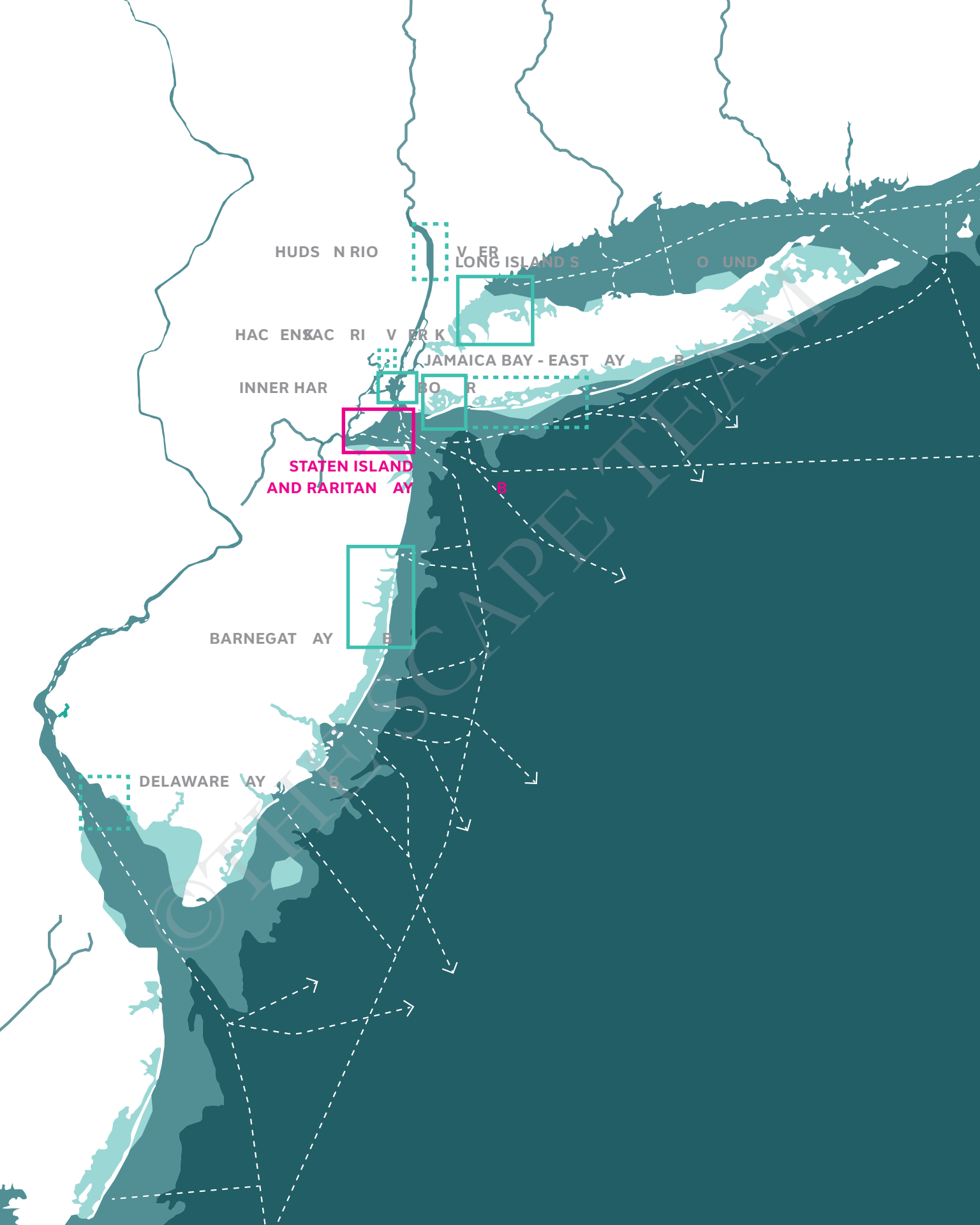
+ ATLANTIC ROCK CRAB

+ ORNATE EGRET

+ NORTHERN SEA SPAR

TABLE OF CONTENTS

3	INTRODUCTION
4	THE PROTECTIVE SHALLOWS
6	BAYS AS ECOLOGICAL INFRASTRUCTURE
8	THE LAYERED APPROACH
10	LIVING BREAKWATERS PROPOSAL
13	REDUCING RISK
14	DESIGN TO REDUCE FRAGILITY
18	SHORELINE LOSS + INUNDATION
22	REDUCING RISK WITH BREAKWATERS
26	TEST RISK-REDUCTION SCENARIOS
30	A SUITE OF REPLICABLE TYPOLOGIES
40	BUILDING ON EXISTING INITIATIVES
43	GROWING ECOLOGICAL RESILIENCY
46	DESIGN FOR JUVENILES
50	THE REEF "STREET"
56	WHAT ABOUT OYSTERS?
62	BIOGENIC BUILD UP
65	BUILDING SOCIAL RESILIENCY
70	COMMUNITY WATER HUBS
73	BUILDING COMMUNITY AROUND WATER
74	HARBOR AS A CLASSROOM
76	COMMUNITY LED DESIGN PROCESS
78	WATER HUB PROGRAMMING
87	PARTNERING & IMPLEMENTATION
90	COMMUNITY & AGENCY INPUT
94	COALITION BUILDING
107	A ROBUST REGULATORY STRATEGY
110	STRONG FUNDING JUSTIFICATION



HUDSON RIVER

VERMILION LONG ISLAND SOUND

CONNECTICUT

HARLEM RIVER VERMILION

JAMAICA BAY - EAST BAY

INNER HARBOR

BOHANNON

STATEN ISLAND AND RARITAN BAY

B

BARNEGAT BAY

B

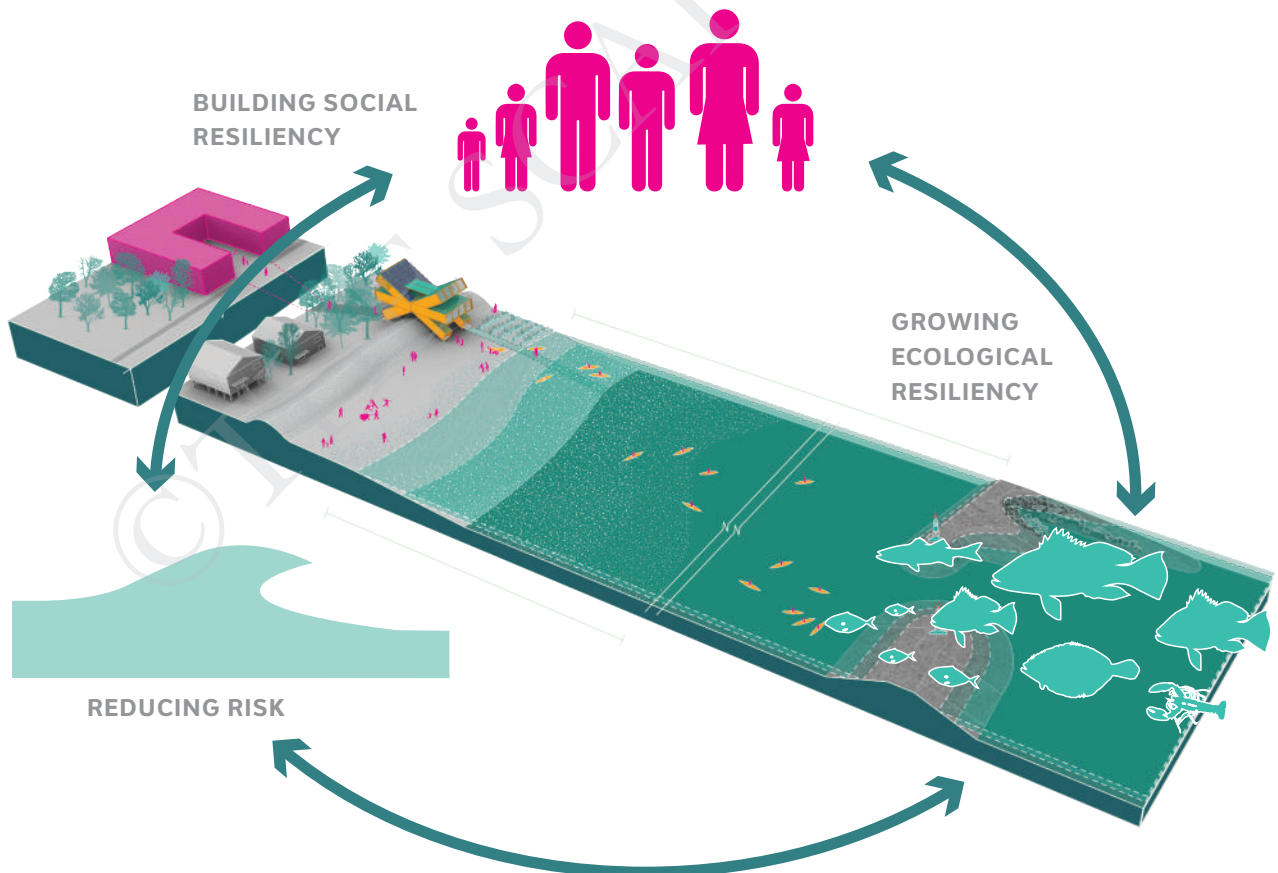
DELAWARE BAY

B

INTRODUCTION

THE LIVING BREAKWATERS PROJECT REDUCES RISK, REVIVES ECOLOGIES, AND CONNECTS EDUCATORS TO THE SHORELINE, inspiring a new generation of harbor stewards and a more resilient region over time. Staten Island sits at the mouth of the New York Bight and is vulnerable to wave action and erosion. Rather than create a wall between people and water, our project embraces the water, increases awareness of risk, and steps down that risk with a necklace of breakwaters to buffer against wave damage, flooding, and erosion. We have designed “reef street” micro-pockets of habitat complexity to host finfish, shellfish, and lobsters, and also modeled the breakwater system at a macro scale to understand how and where they can most effectively protect communities. This living infrastructure will be paired with social resiliency frameworks in adjacent

neighborhoods. Through the Billion Oyster Project and an associated network of programmed Water Hubs, local schools will be empowered with science, recreation, education, and access. Our approach is especially suited to Staten Island’s South Shore, but it is also replicable in other waterfront communities faced with the similar duality of risk and opportunity presented by their connection to the water. Tottenville, the site of our proposed Phase One pilot, was once known as “the Town the Oyster Built.” During Sandy, lives were tragically lost, and homes and parks were severely damaged. Moving forward, we can foster a vibrant water-based culture, invest in our students, shoreline ecologies and economies, and Tottenville can claim the mantle as the Town the reef re-built.



THE PROTECTIVE SHALLOWS

Staten Island's South Shore was once buffered by a wide shallow bathymetric shelf known as the "West Bank." Oysters and clams once played a major role in the Raritan Bay ecosystem and economy. Reefs and leased oyster beds extended across the shallow water flats of Raritan Bay, reducing storm impacts and

filtering water. Over time, dredging and the collapse of oyster populations diminished its capacity to protect the shore. Staten Island can also look back at a rich history of recreational facilities along the shoreline that Staten Islanders started populating in the early 19th century.

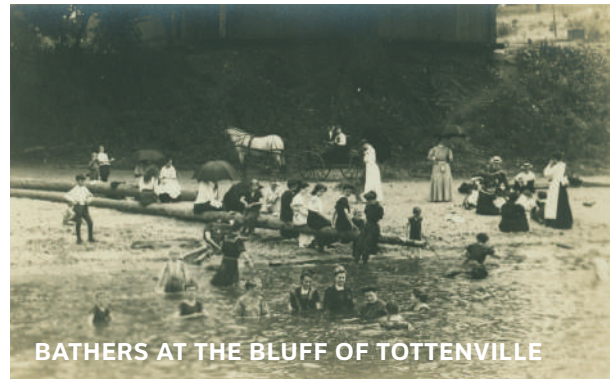
"RAKING FOR OYSTERS" AT PRINCE'S BAY, 1869



Bathing Hour, Crescent Beach. Great Kills, Staten Island, N. Y.



CRESCENT BEACH, AROUND 1900



BATHERS AT THE BLUFF OF TOTTEVILLE

SHALLOW BATHYMETRY AND HISTORIC OYSTER BED LOCATIONS IN THE NEW YORK HARBOR



BAYS AS ECOLOGICAL INFRASTRUCTURE

Beyond Raritan Bay, the Northeast region hosts many bay landscapes that were directly affected by Hurricane Sandy and face continued risks from urbanization, contamination, sediment starvation, and sea level rise. In stage II of the Rebuild by Design competition, our team mapped potential enhancements to endangered bay landscapes and communities including Barnegat Bay, Raritan Bay, the Inner Harbor, Jamaica Bay, the Great South Bay, and others along the Upper Hudson. We developed a range of design ideas to nourish this bay system to not only help protect us from extreme storm events but also to improve the quality of our everyday lives.

The shallow bay landscape of Raritan Bay - the focus of our RBD stage III focus and this report - is a complex and critical area of topography, maritime economic activity, and recreation, and hosts historic ecosystems which are under threat of disappearing. In addition, this landscape bears the immense potential for educational engagement and community participation in their safekeeping. Interconnected systems by their very nature are more resilient - they are not dependent upon one element to succeed or fail but rather offer networked opportunities for change and continual recalibration. To us, this is the definition of resiliency.





REGIONAL APPROACH

The Northeastern Seaboard contains several shallow water bay landscapes with shoreline communities at risk. These endangered bays are key test sites for the layered approach described on the following page.

THE LAYERED APPROACH

Our project combines **COASTAL RESILIENCY** infrastructure with **CLIMATE ADAPTATION** techniques and **COMMUNITY ENGAGEMENT** models, deploying a layered strategy that links in-water protective forms to on-shore interventions. We aim to advance ideas that help protect us from periodic weather extremes while improving the quality of our everyday lives.

New York City faces a high degree of potential risk. Rather than cut communities off from the water with a levee or wall, we need to embrace the water and its economic and recreational opportunities, using shallow water landscapes to stabilize the shore. Ecosystems can be restored to step down risk faced by coastal communities and to rebuild diverse habitats. The **LAYERED APPROACH** extends across a thick section, creating multiple lines of defense that will not fail singularly and catastrophically.

People are a critical component of any ecosystem. Thus we have developed a framework to link people with the shoreline and with the water through education, engagement, and the expansion of a water-based recreational economy. Shallow, slow, and safe water opens up a variety of in-water programming opportunities, from sport diving to charter fishing to kayaking to citizen stewardship, all enabled by the layered approach to risk reduction.

- FLOATING CLASSROOM

SCIENCE CENTER

KAYAK LAUNCH

FISH CLEANING STATION

FISHING GEAR RENTAL

BIRDING POINT

SEA WALL

EMERGENCY RESPONSE

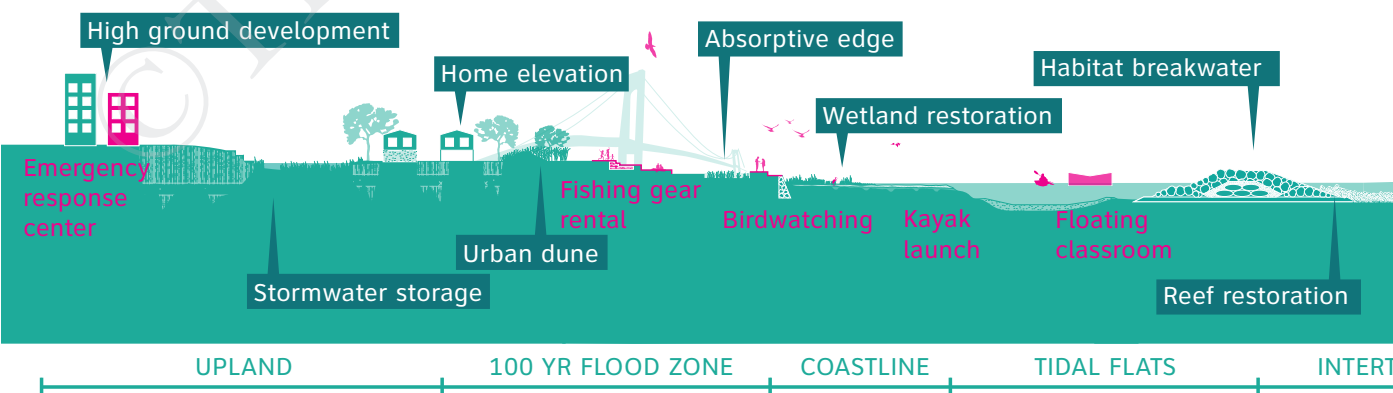
COMMUNICATIONS

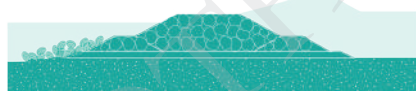
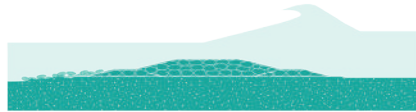
ESCAPE ROUTE

TRAIL HEAD

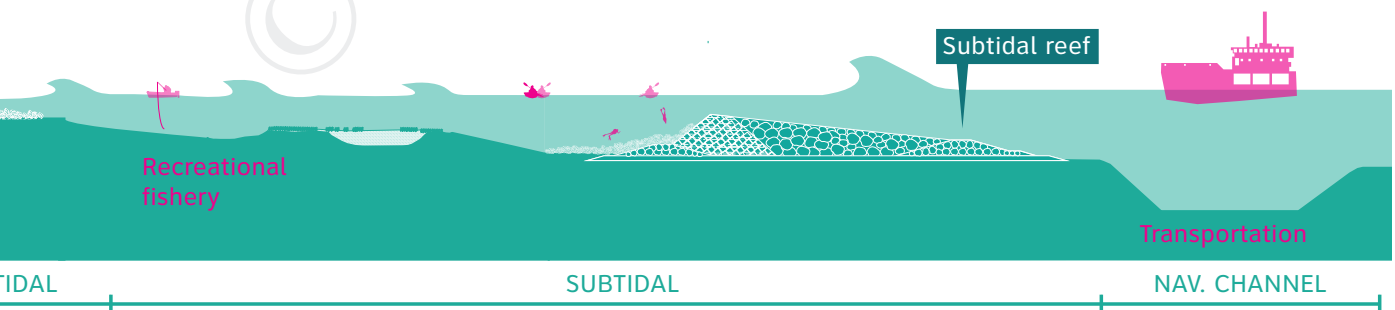
OVERLOOK TOWER

ON WATER BASED COMMUNITIES





LOW SALT MARSH
HIGH SALT MARSH
M. ARITIS M. ESHRU
M. ARITIS FORESE
M. ARITIS M. LEAT M
BEACH
DUNE
SALT PANNE
SALT SHRU
DUNE SLAC
SU TIDAL REE
BARRIER ISLAND



LIVING BREAKWATERS PROPOSAL

STATEN ISLAND'S SOUTH SHORE

Living Breakwaters are strategically sited relative to the South Shore of Staten Island to reduce risk for coastal communities, build reef habitat for juvenile fish and shellfish, and enhance waterfront recreation and stewardship. In areas of high land loss and risk to infrastructure, they are located to encourage sedimentation and help build back the beach. In more ecologically or economically sensitive zones, such as hard clam habitat areas, their footprint is minimized or realigned.

The project strengthens ongoing shoreline improvements and creates opportunities for rethinking the coastal edge. For example, new dune systems created by the NYC Department of Parks and Recreation will be protected from erosion by the offshore system, and new seawall constructions can incorporate living marsh elements due to lower wave velocity. Structures called Water Hubs are located at critical points along the shore and serve as places of gathering for classes, orientation, kayak & equipment storage, data monitoring, and emergency response. Combined, the system creates a crucial link between communities, schools, and the water's edge.

PHASE 1

THE TOTTEVILLE REACH

This approximately 13,000 LF stretch protects the Tottenville community and valuable parklands at Conference House Park.

PHASE 2

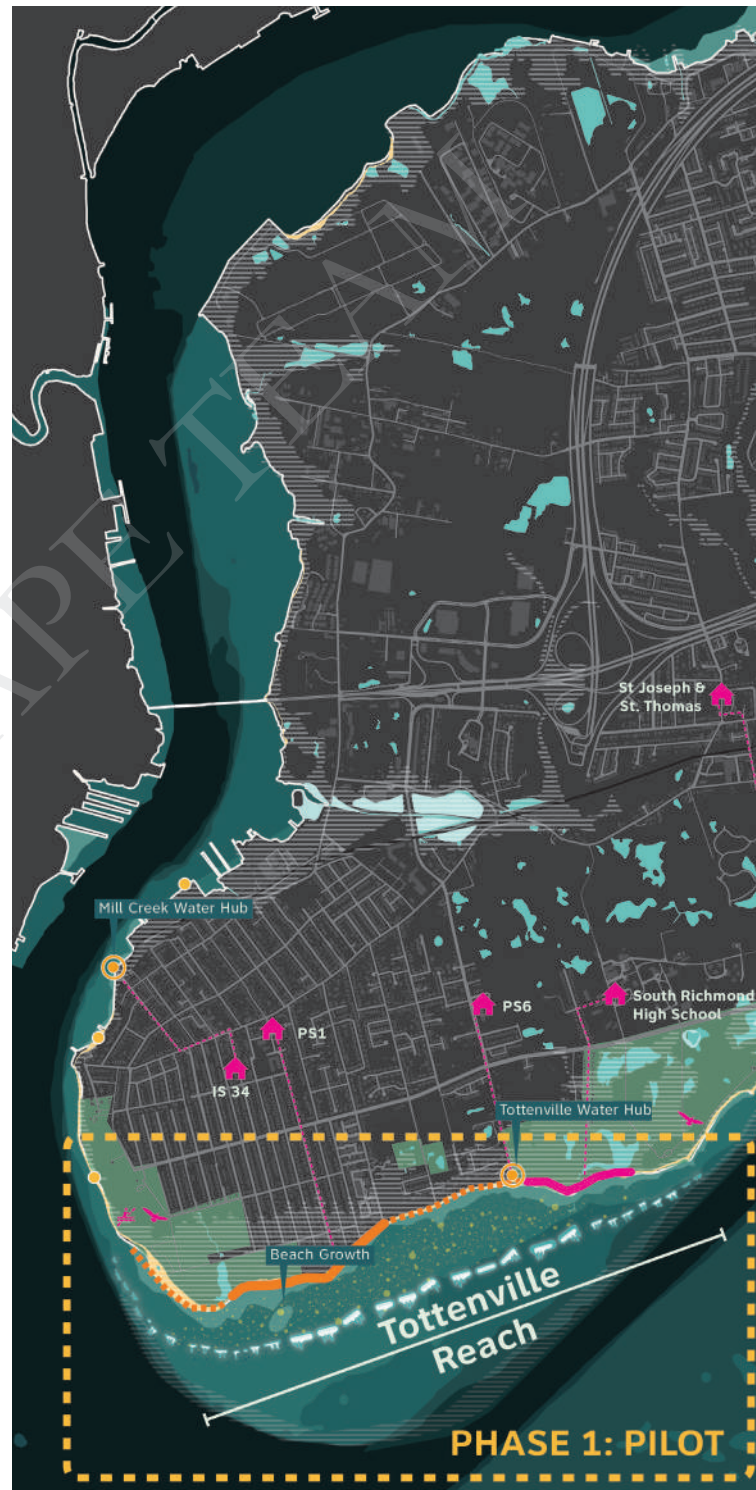
CRESCENT BEACH AND ANNADALE REACH

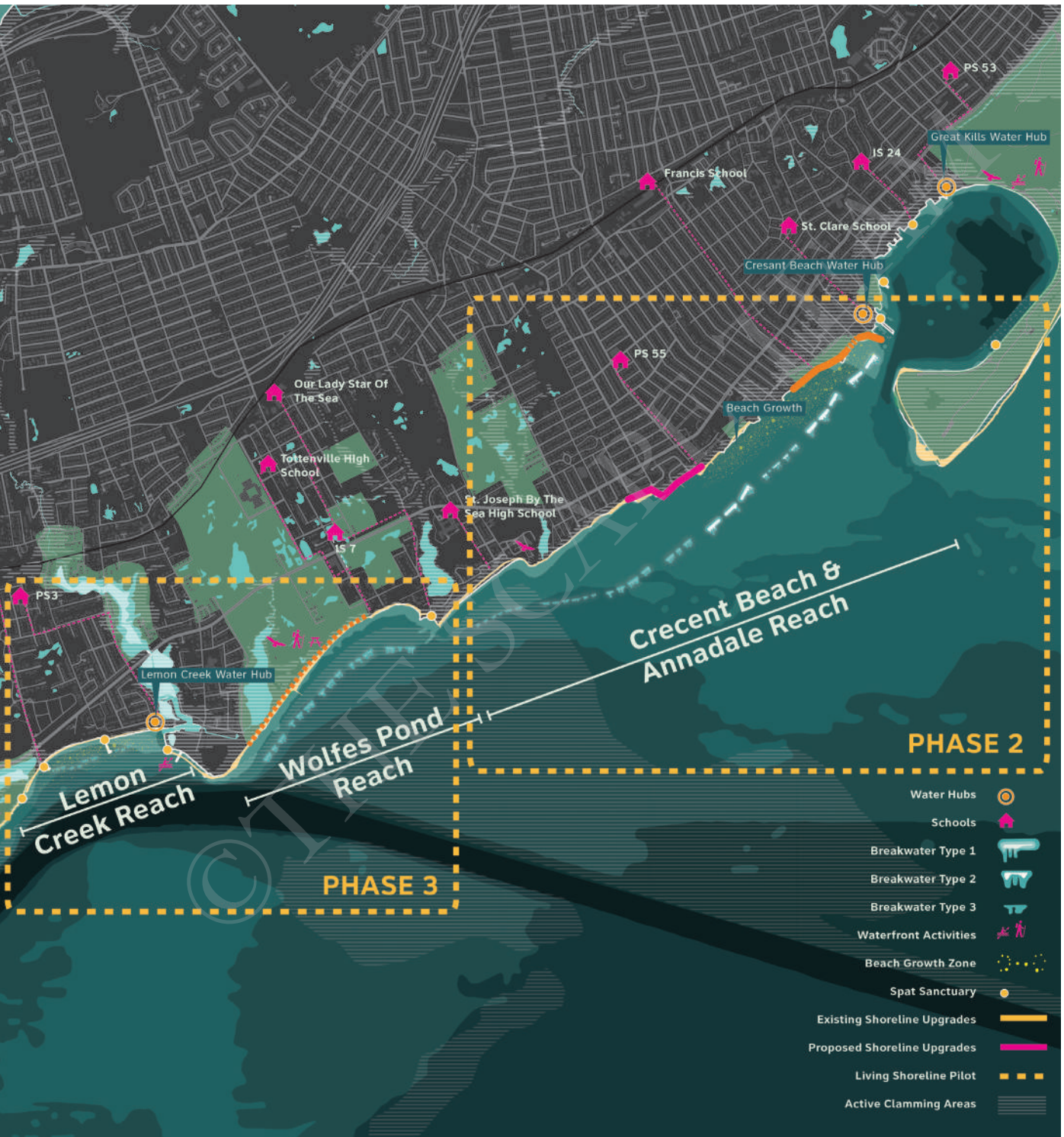
This 6000-7000 LF stretch protects communities from Crescent Beach to the mouth of Great Kills Harbor.

PHASE 3

LEMON CREEK & WOLFES POND REACH

Protects Lemon Creek, Prince's Bay, and valuable State Parklands.





COASTAL EROSION ALONG STATEN ISLAND'S SHORE



REDUCING RISK



©THE SCAPE TEAM

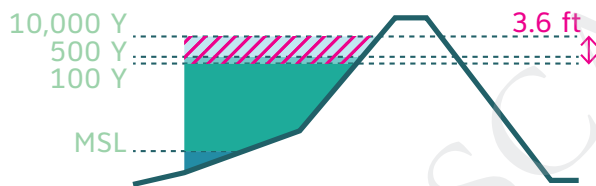


DESIGN TO REDUCE FRAGILITY

Risk is embedded in all coastal resiliency strategies. Our approach aims to step down risk with each investment, redefine scales of harm, and move beyond the impossible scenario of enclosing “dry” from “wet” to address larger issues of ecosystem collapse, cycles of regional decline, and managed, calmer, and non-disastrous inundation events. We build up resiliency by strengthening networks, incrementally decreasing the overall risk embedded

in the system. Our strategies mitigate the impacts of flooding without eliminating it altogether and re-focus the region on ecologically driven improvements that make flooding slower, cleaner, and safer, and less prone to catastrophic failure. We aim to make risk legible and part of everyday life, while building ecological and social resiliency through new stewardship programs on the waterfront.

NETHERLANDS



NEW YORK CITY



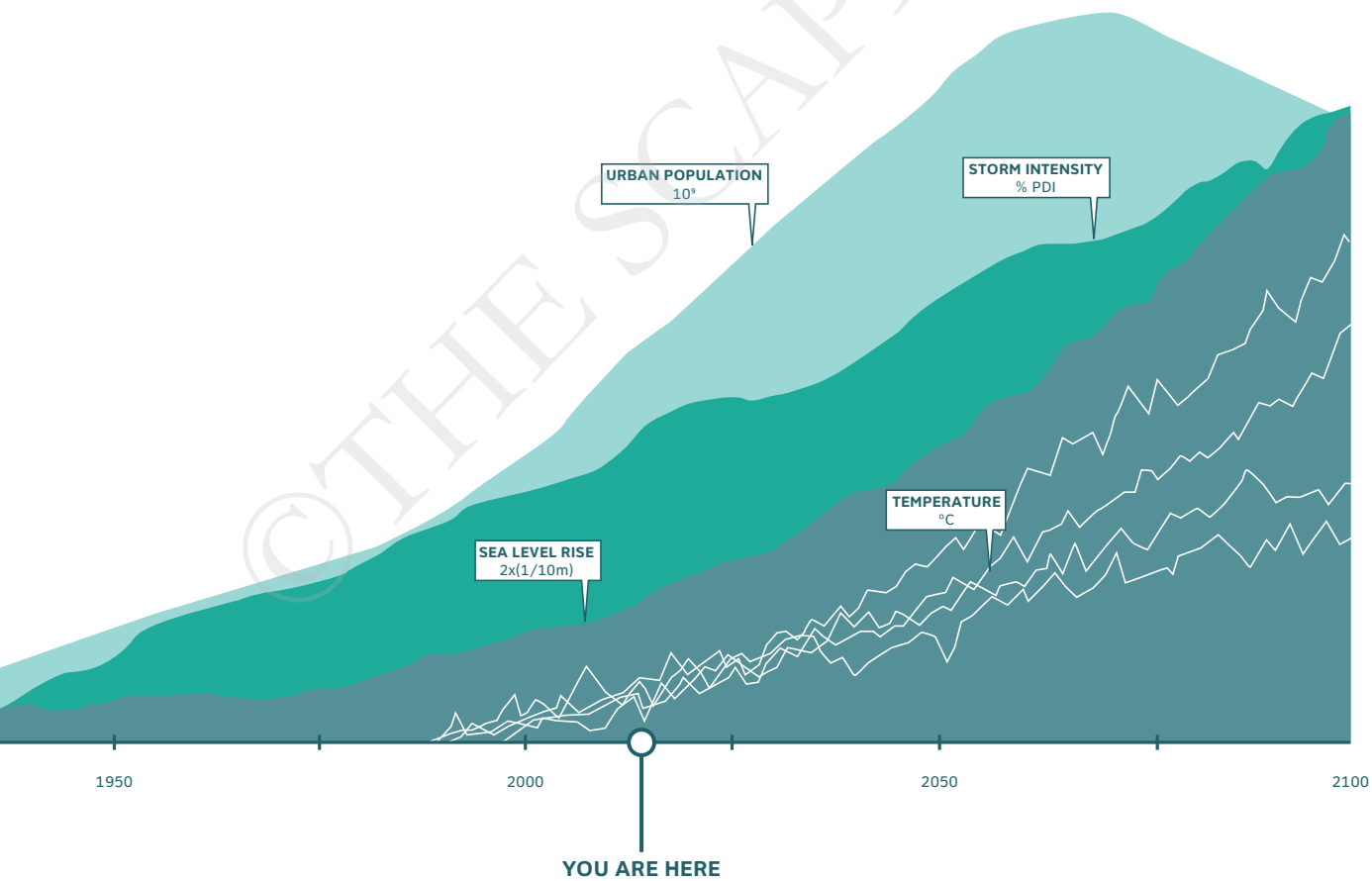
COMMUNITY FRAGILITY New York City faces high degrees of uncertainty when planning for risk, mostly due to the variable nature of hurricanes. We propose to move beyond single-use flood infrastructure, focusing instead on the **LAYERED APPROACH**.

1850

1900

Climate change is bringing new challenges to the eastern seaboard of the United States. Its predicted effects include a rise in mean temperature and precipitation, accelerated sea level rise, and more frequent, extreme flooding and storm events like Hurricane Sandy. These phenomena, coupled with the excess nitrogen levels in our waters from treated wastewater and fertilizers put our critical estuaries and bays at risk of disappearing within decades, if

not years. With their shallow bathymetry and delicate balance of vulnerable marine life, a loss of these endangered waters would threaten not only the places we live, work, and play in but also our cultural connection to the water. We know that in addition to being beloved fishing and recreational grounds, bay landscapes are crucial absorptive ecological infrastructure that help reduce risk for communities located along the water's edge.



SHORELINE LOSS + INUNDATION

STATEN ISLAND AND RARITAN BAY

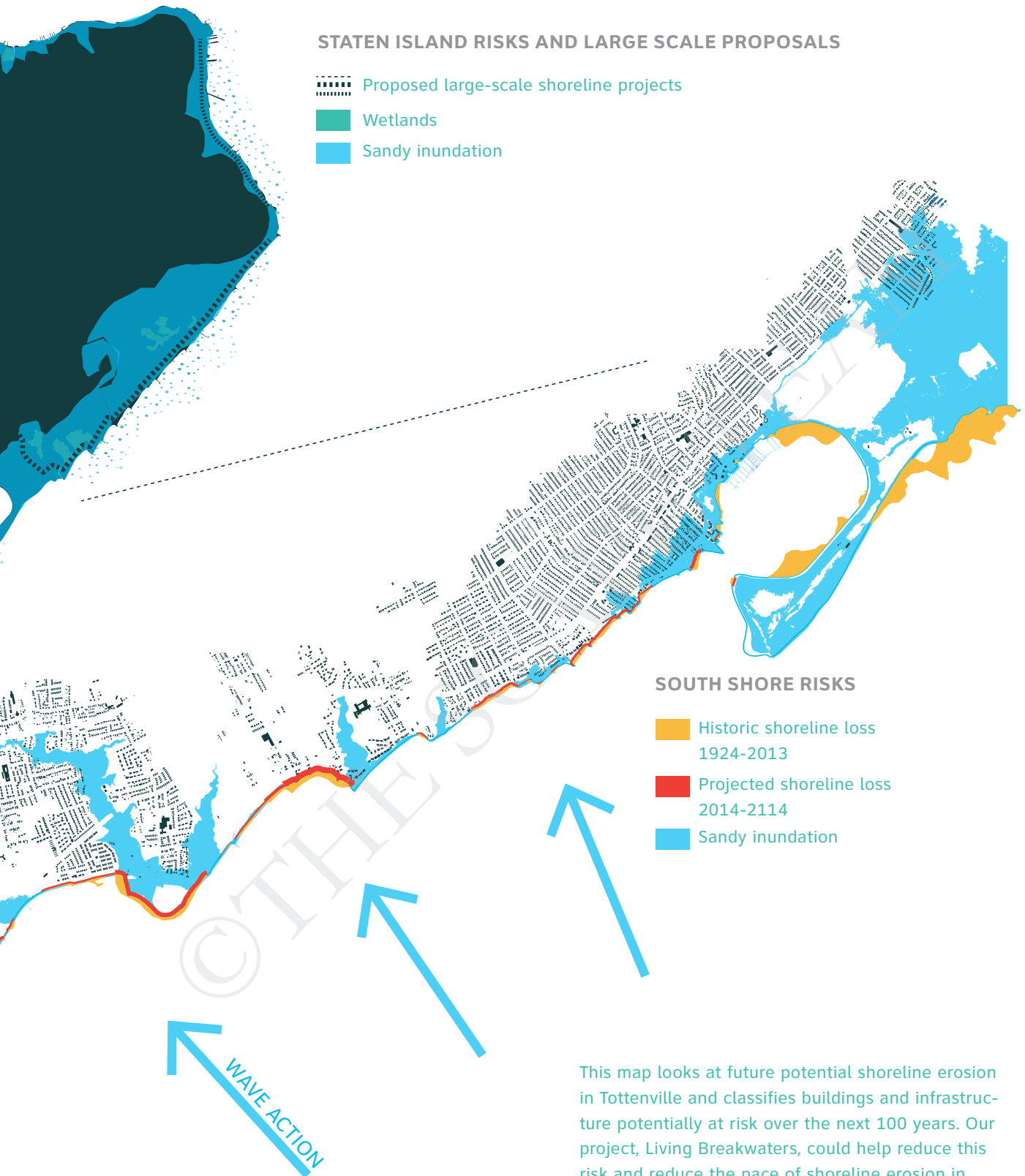
Staten Island is exposed to extreme wave action and storm surge during hurricane events due to its location directly at the mouth of the New York Bight. Within Staten Island, however, the impacts of Hurricane Sandy were highly localized – the East Shore was impacted differently than the North Shore or South Shore. Each condition requires a localized response, but in all instances, can be paired with ecological and recreational systems for greater public benefit and longevity.

Living Breakwaters proposes layered strategies for risk reduction in these neighborhoods closely connected to the water. Our project helps to preserve a cultural, lived relationship with the water by protecting water based economies such as sport and charter fishing, marinas, and small waterfront structures such as restaurants.



STATEN ISLAND RISKS AND LARGE SCALE PROPOSALS

- Proposed large-scale shoreline projects
- Wetlands
- Sandy inundation



SOUTH SHORE RISKS

- Historic shoreline loss 1924-2013
- Projected shoreline loss 2014-2114
- Sandy inundation

This map looks at future potential shoreline erosion in Tottenville and classifies buildings and infrastructure potentially at risk over the next 100 years. Our project, Living Breakwaters, could help reduce this risk and reduce the pace of shoreline erosion in Tottenville.

VULNERABLE SHORELINE COMMUNITIES

On the South Shore, coastal erosion and land loss combine with wave action for catastrophic effect. The area has lost acres of land over the last 100 years. Over time, beaches become narrower and less public, communities become more exposed. Infrastructure crumbles into open water, parklands are lost, and critical ecosystems are destroyed. Without action, the shoreline will continue to erode and threaten the communities of Tottenville, Prince's Bay, Lemon Creek, Great Kills, Crescent Beach, and Annadale.



“
Kids don’t use our
beaches because
they are cut off.
- S.i. Resident
”



TOTTENVILLE WATER ACCESS CONFLICT



“ Sandy damaged and eroded a lot of the beaches I used to take walks on. - S.I. Resident ”

TOTTENVILLE EMERGENCY DUNE



LEMON CREEK CLIFF EROSION

SANDY DAMAGE ASSESSMENT

This map - one of a sequence along the entire coast - integrates flooding extents with anecdotal data or damage, debris, and water flow provided by the community to describe and assess damages experienced due to Superstorm Sandy.

- Wetlands Trail (Mt Loretto)
- Beach Trail (Mt Loretto)
- Conference House Park Trails
- Major land erosion
- Minor land erosion
- Erosion along the beaches
- Sedimentation along the beaches



Parksland

Inundation from Sandy storm surge

Major debris on land from Sandy

Buildings Inundated,
6-18 ft standing water

Buildings Inundated,
3-6 ft standing water

Buildings Inundated,
0-3 ft standing water

Bodies of water on land

500-year flood line

100-year flood line

Coastal High Hazard Area

LiMWA

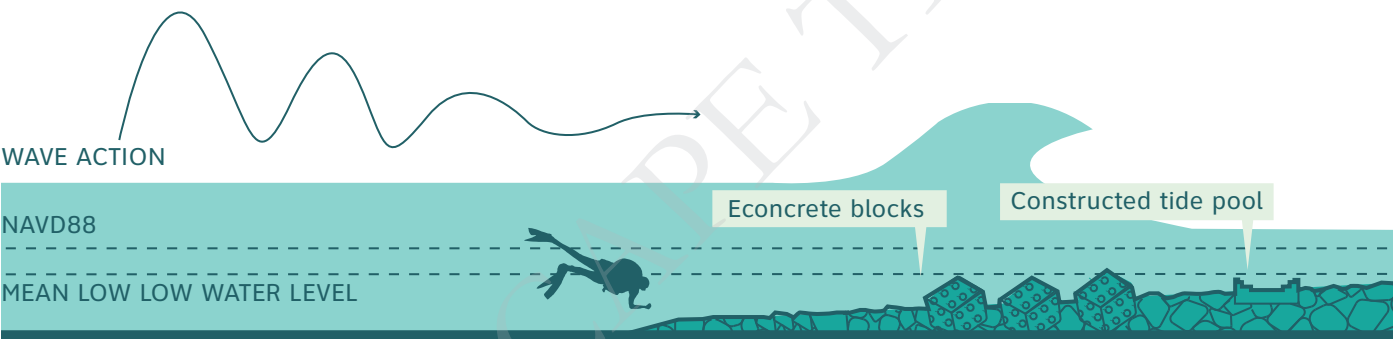
Maritime locations damaged



REDUCING RISK WITH BREAKWATERS

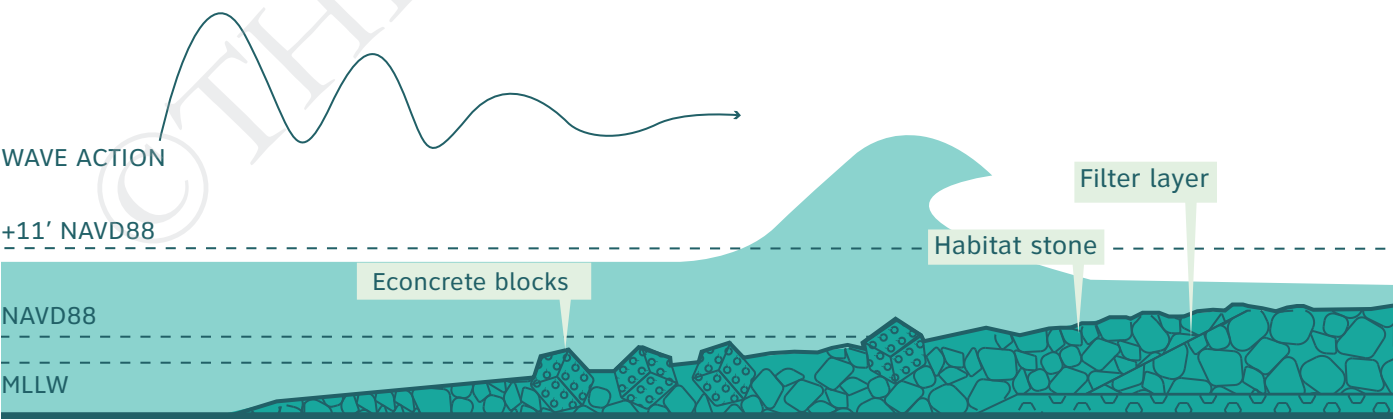
Conventional techniques that “protect” us by erecting a barrier between people and water ultimately sever our visual and physical relationship to the water. We want to reduce risk while increasing our perception of risk by building a landscape scale intervention that integrates aquatic habitat and community access.

Breakwaters do not keep the water out, however, they have the ability to calm water, reduce wave heights, and prevent shoreline erosion. High velocity water - such as when a levee is overtopped - can be fatal.



SUBTIDAL

BREAKWATER

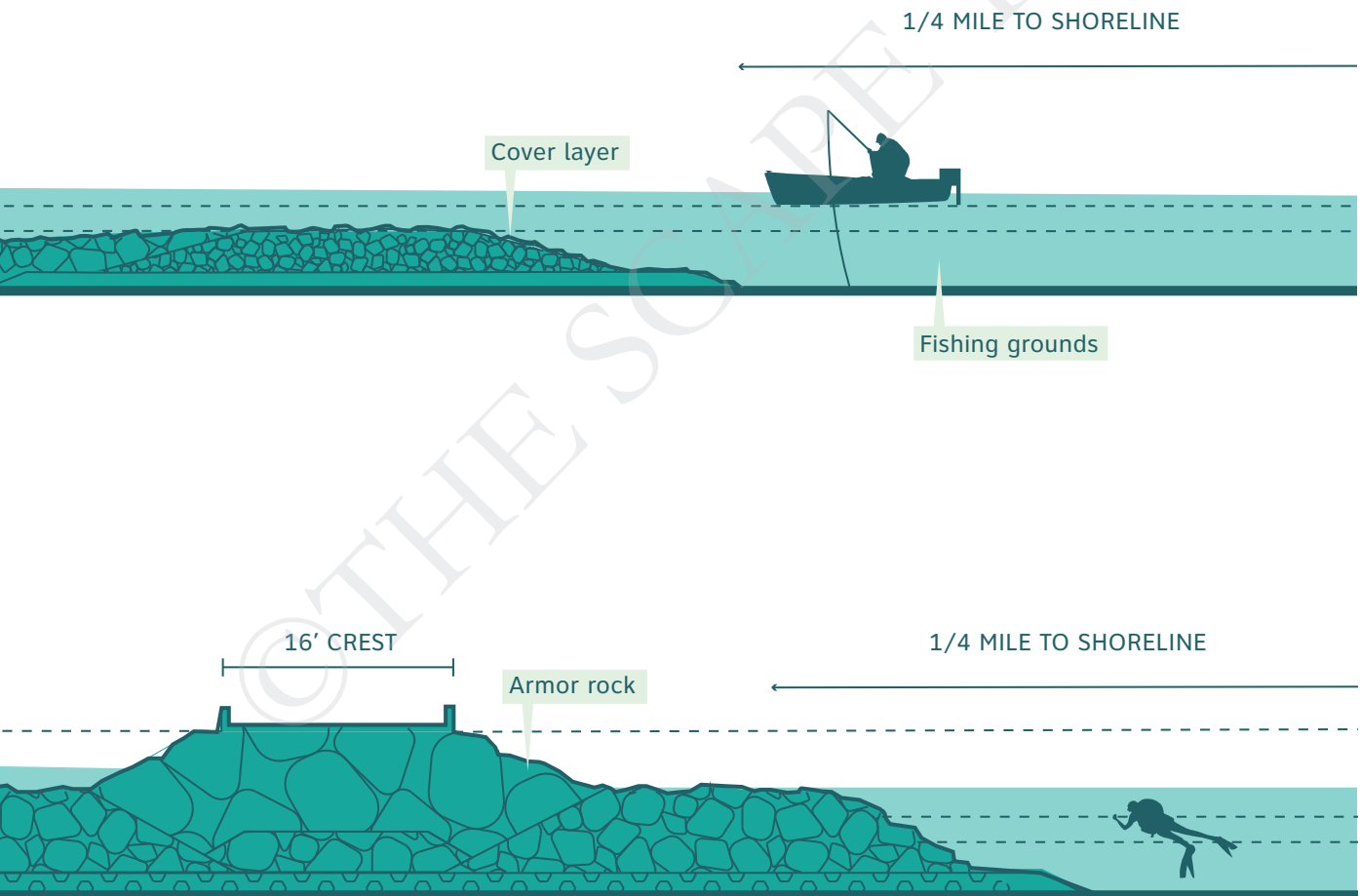


EMBANKMENT

BREAKWATER

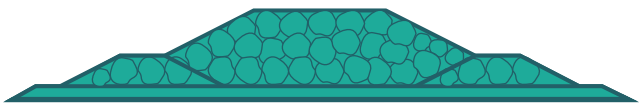
Breakwaters absorb wave energy and create slow moving water, which can save lives, reduce damage to structures, and reduce floodwater elevations. Calm water in turn encourages sedimentation, which replenishes protective beaches. Designed with attention to materiality, scale, and location, these

breakwaters will enhance maritime ecosystems and link risk reduction with a renewed stewardship of a biodiverse and activated Raritan Bay shoreline. Designed as living systems, they build up biogenically in parallel with future sea level rise



HABITAT BREAKWATERS

Breakwaters reduce risk at the shoreline by reducing wave velocity and reducing shoreline loss - they do not keep out flood water.



DO

REDUCE EROSION

LESSEN WAVE IMPACTS

PROVIDE HABITAT

ENCOURAGE RECREATIONAL FISHERIES

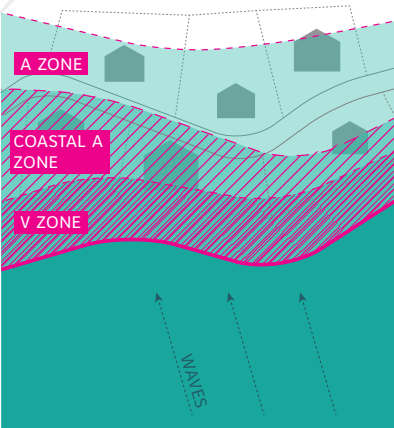
DO NOT

KEEP OUT FLOOD WATER

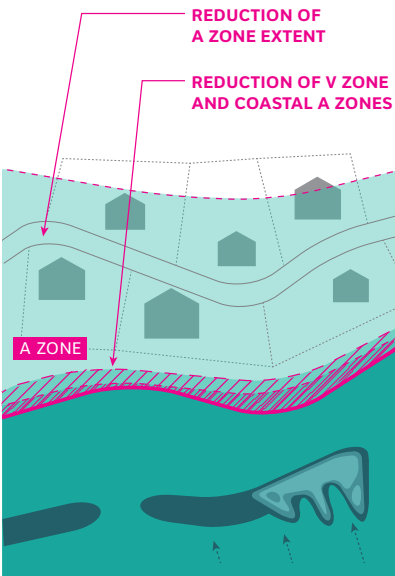
FLOOD HAZARD REDUCTION



EVERYDAY



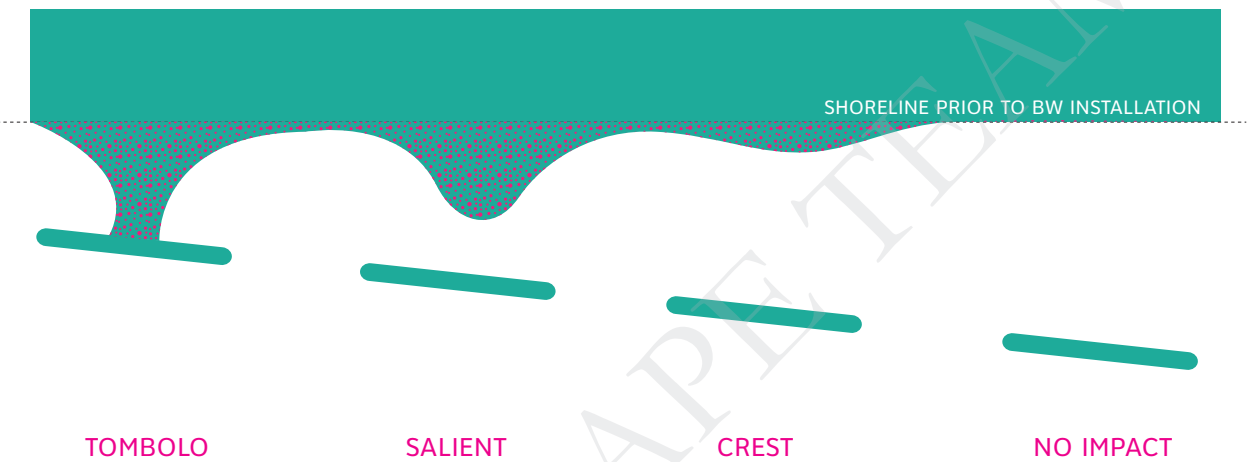
FLOOD EVENT



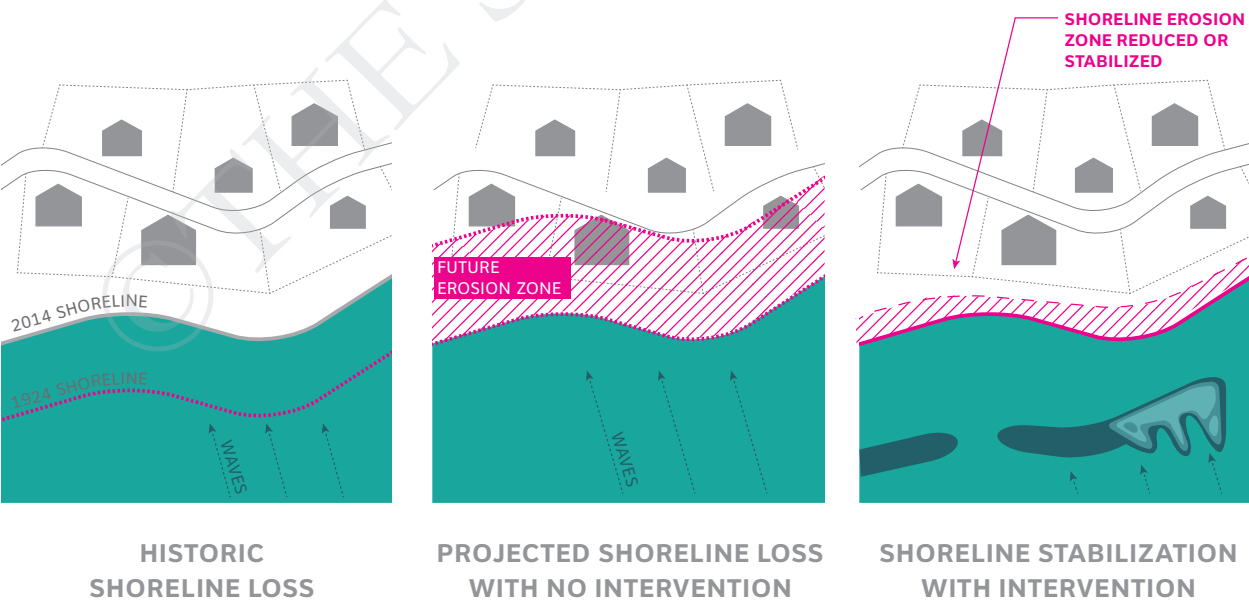
FLOOD EVENT
+ BREAKWATER

SEDIMENTATION STUDIES

Breakwaters can be designed and located to encourage or discourage sedimentation along the shoreline. Sedimentation can help to extend the beach, useful in areas of high erosion. Sedimentation is not desirable close to critical habitat or navigation channels.

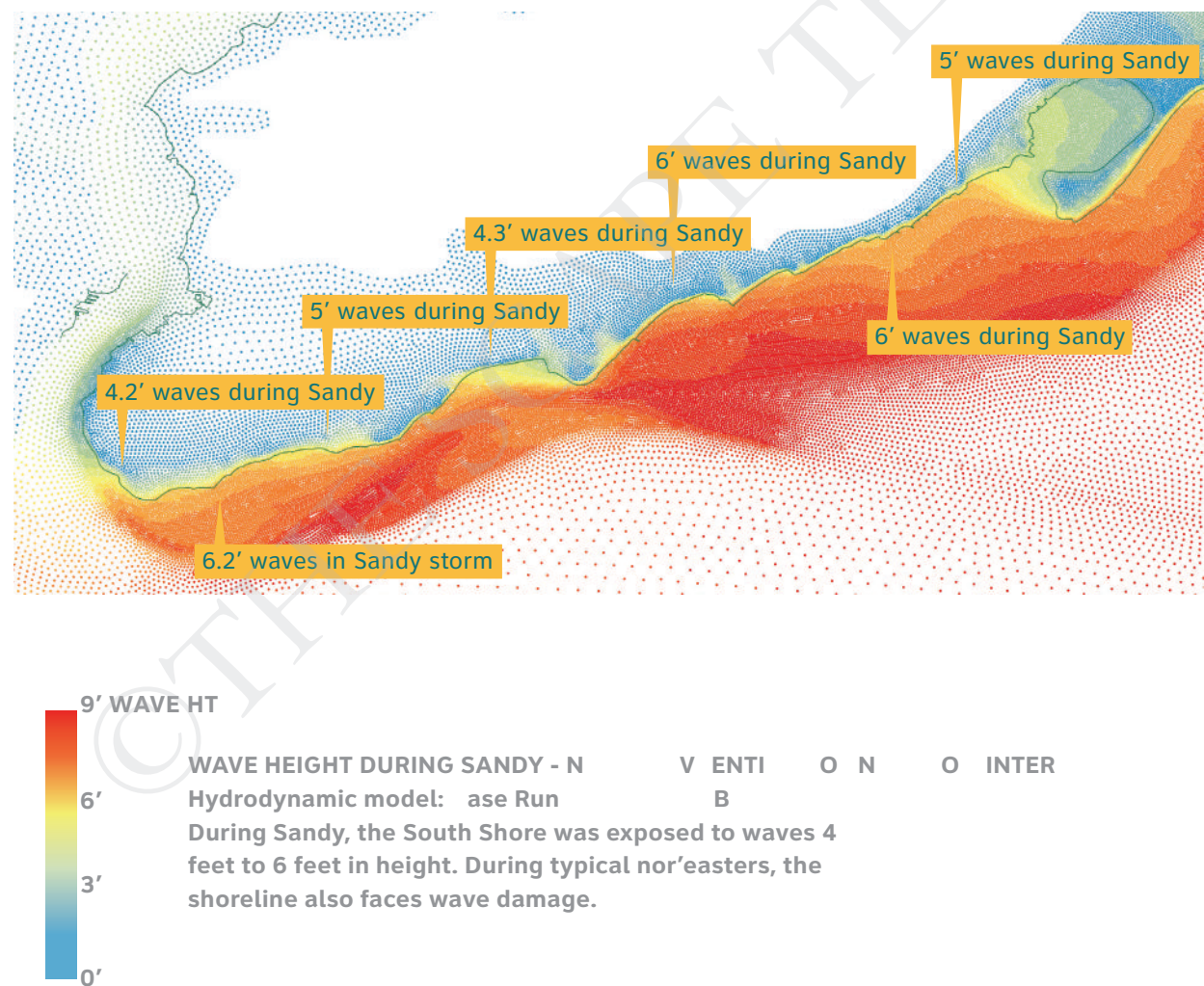


COASTAL EROSION REDUCTION



TEST RISK-REDUCTI N SCENARIO S

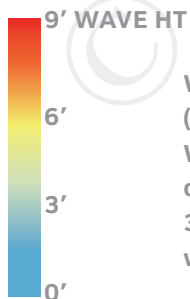
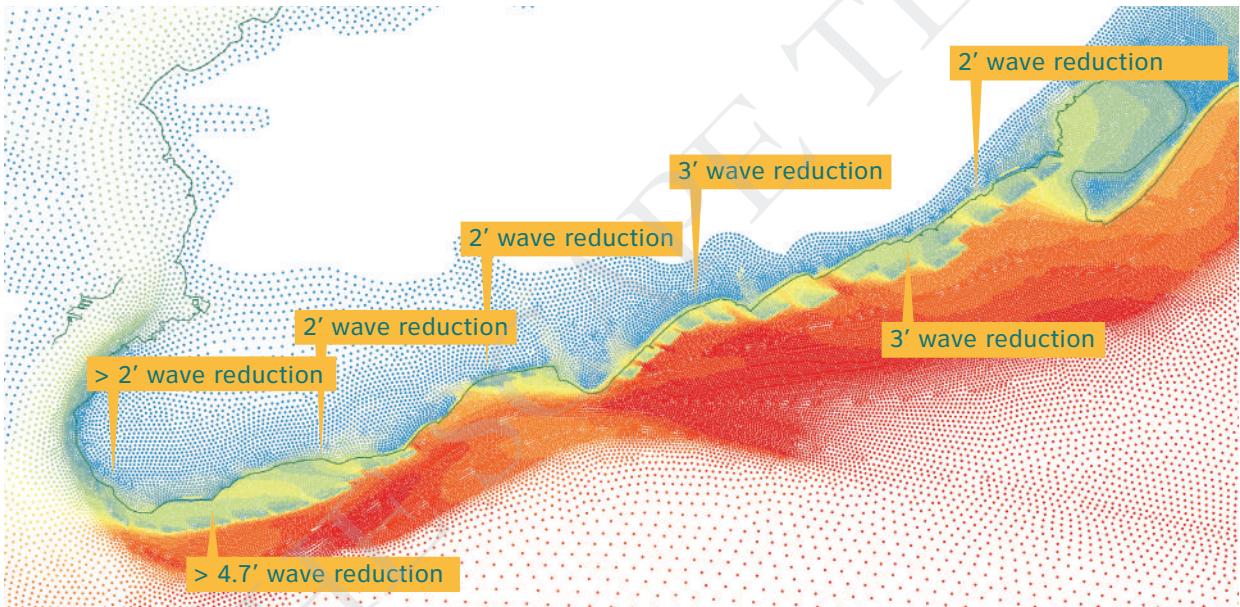
Communities that were flooded by Sandy face complex decisions about the future, and a quantification of flood and wave risk-reduction is a useful tool to understand these direct physical benefits of ecological infrastructure. Having developed a suite of strategies that could be applicable for coastal protection against storm surges, it was imperative that the team tested their performance using the latest scientific tools.





“In flooding events, inches matter.”
- NY Rising Committee Member

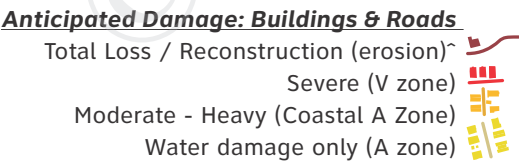
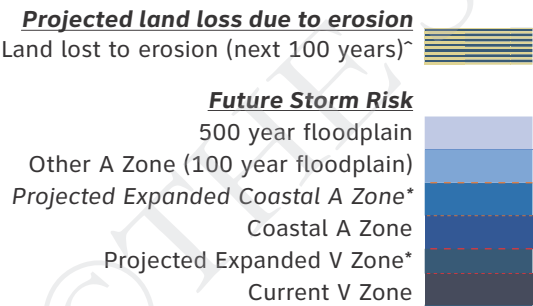
With Dr. Philip Orton of the Stevens Institute of Technology, we have evaluated the proposed strategies using a computerized model – the ADCIRC/ SWAN storm surge and wave modeling system. The model results show that having exposed breakwaters for Hurricane Sandy led to wave height decreases of 4.0 feet and base flood elevation reductions of 4.5 feet at Staten Island’s South Shore, by causing partial breaking and a reduction in wave heights as they passed over the breakwater.



WAVE HEIGHT DURING SANDY - WITH INTERVENTION
(all breakwaters modeled as exposed)
With a system of entirely exposed breakwaters, wave damage risk during a Sandy storm reduces greatly, up to 3 feet- 4.5 feet in select zones. During typical nor'easters wave damage may be entirely avoided.

RISK REDUCTION ANALYSIS: TOTTONVILLE PILOT PROJECT (100 YEAR)

The “baseline scenario” - what would happen in the future without the project? - took a number of factors into consideration: Tottenville’s shoreline is eroding. If historic rates continue, we predict approximately 20 acres of land lost to erosion, mostly parkland. This will decrease the distance between homes, businesses, and critical infrastructure, and the shoreline, in some cases causing these assets to be lost to erosion. Even if not directly impacted by erosion, the loss of shoreline will increase exposure to waves during a storm event as long as there is not limiting topography, effectively increasing the extent of V and Coastal A zones and associated increases in Base Flood Elevations. Exposure to intense wave action and higher water velocities will continue to put people’s lives and safety at risk. The baseline scenario did not consider the added risk of sea level rise in this impact analysis.



[^] Erosion is independent of storm event.
 * Wave zones are anticipated to increase proportionally with the receding shoreline as long as the elevation exceeds the current BFE in the existing V and Coastal A zones.

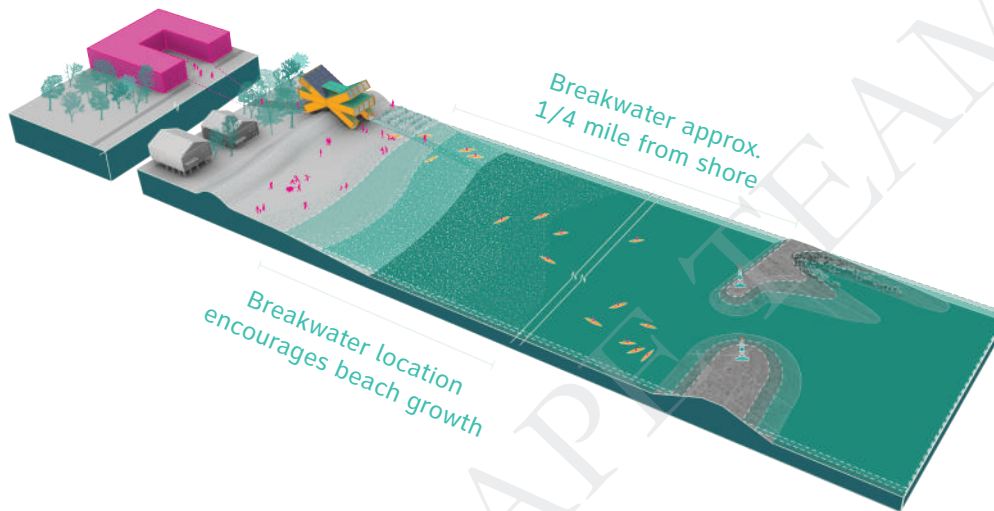




A SUITE OF REPLICABLE TYPOLOGIES

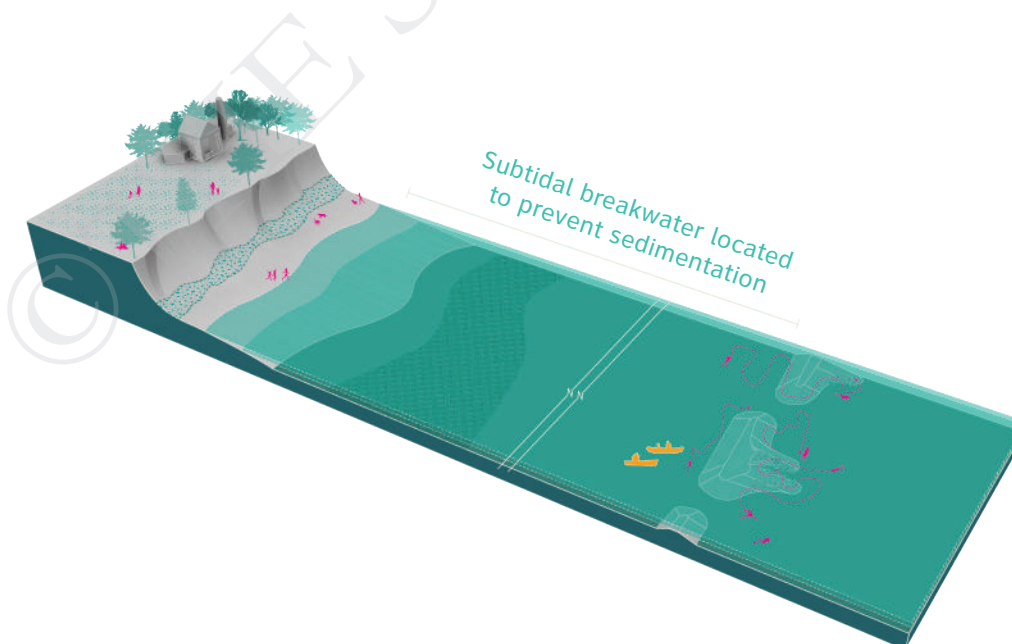
REVIVE RECREATIONAL ECONOMIES

CASE STUDY SITE: TOTTEENVILLE, STATEN ISLAND



PROTECT SENSITIVE ECOSYSTEMS

CASE STUDY SITE: MT. LORETTO STATE PARK, STATEN ISLAND

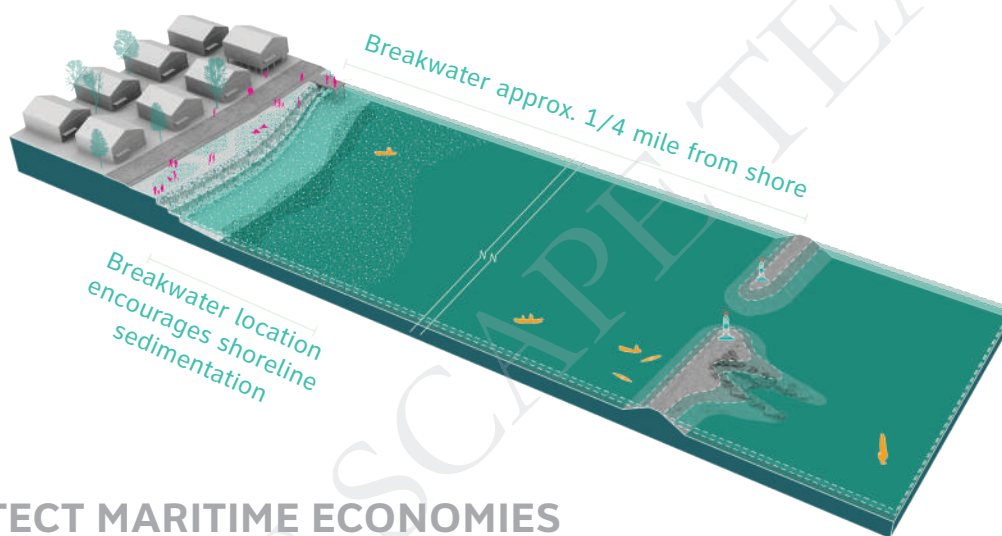


The **LAYERED APPROACH** takes distinct configurations along multiple stretches of shoreline. The concept is replicable yet highly contextual, as the combination of breakwaters and living shoreline techniques is applicable over a broad range of conditions. In addition to helping reduce erosion and wave heights at the shoreline, breakwaters can be designed to catalyze new

forms of waterfront occupation, grow beaches, protect sensitive ecosystems, and enable more ecologically and aesthetically sensitive methods of shoreline construction. Design considerations include breakwater design height, width, distance to shoreline, and length. Each condition shown here uses these design parameters differently to propose a new relationship between Staten Islanders and the shore.

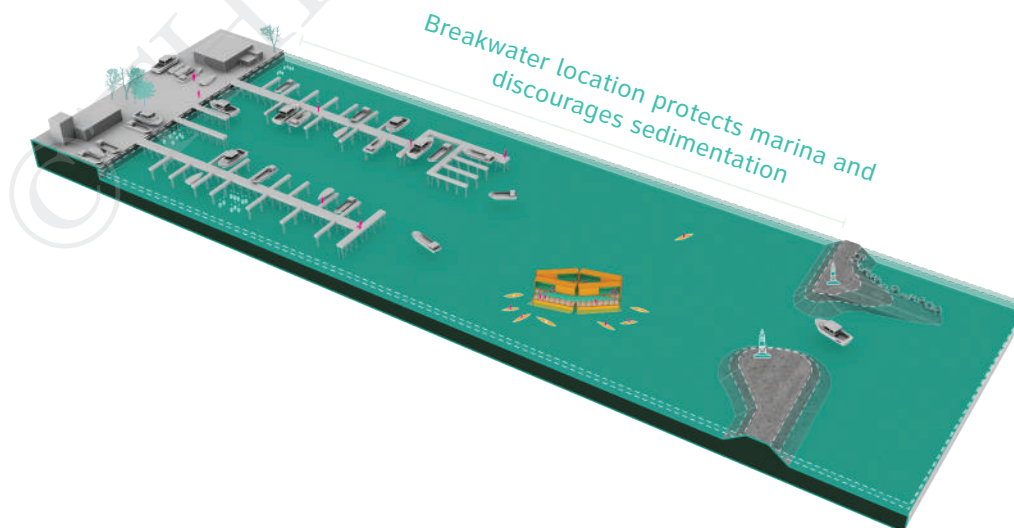
ENABLE NEW EDGES

CASE STUDY SITE: ANNADALE AND CRESCENT BEACH, STATEN ISLAND

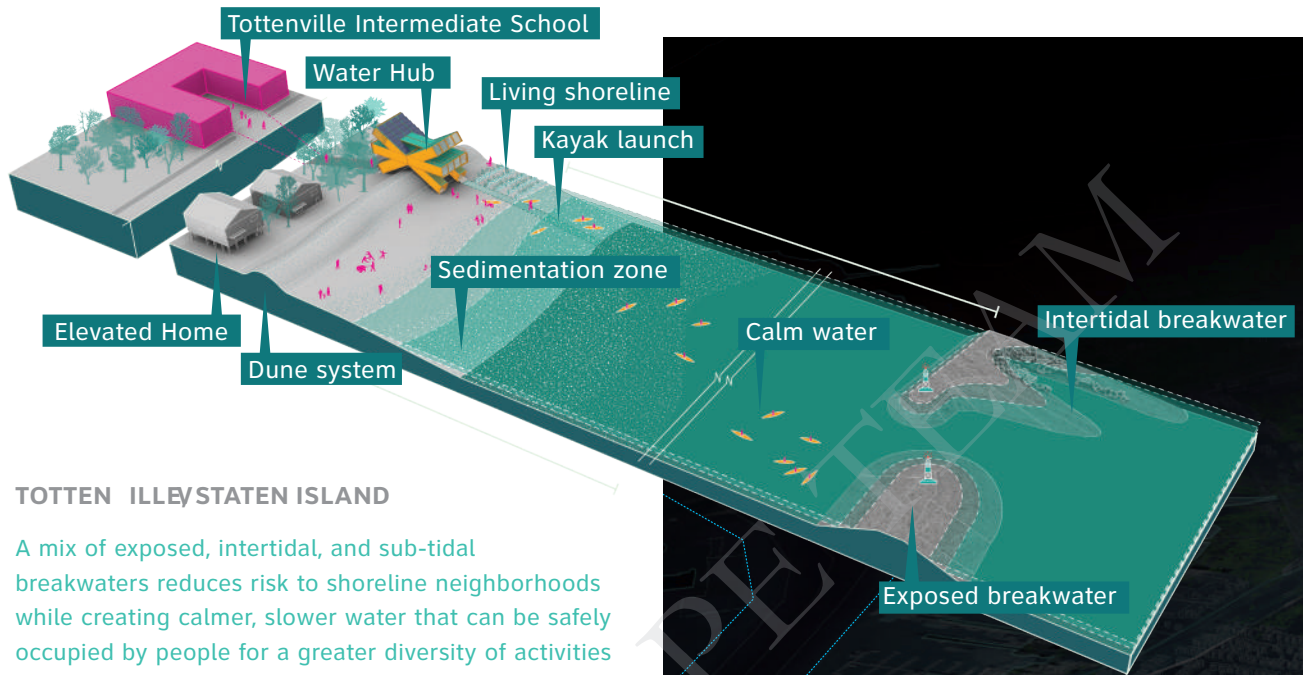


PROTECT MARITIME ECONOMIES

CASE STUDY SITE: GREAT KILLS HARBOR, STATEN ISLAND



REVIVE RECREATIONAL ECO N OM IES

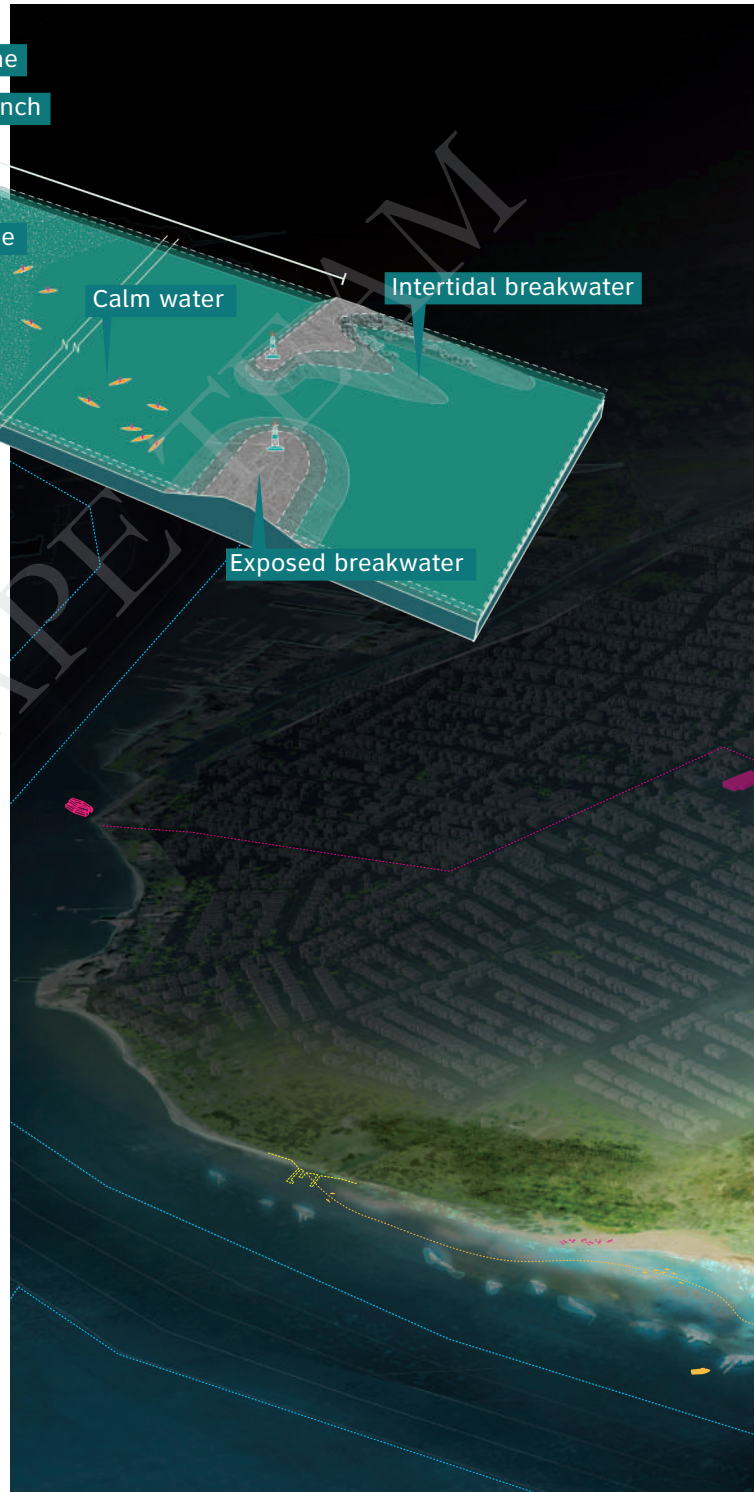


TOTTENVILLE/STATEN ISLAND

A mix of exposed, intertidal, and sub-tidal breakwaters reduces risk to shoreline neighborhoods while creating calmer, slower water that can be safely occupied by people for a greater diversity of activities and programs. In Tottenville, the introduction of the breakwater system and the Water Hub enable local community partners, such as Kayak Staten Island and Conference House Park, to more fully enjoy the protected shoreline and calmer water.

PHASE 1: PILOT PROJECT

Constructing a pilot project that implements all elements of the project: physical, ecological, and social is a critical next step. The proposed Tottenville Phase I pilot will be used to study the ecological benefits, wave reduction impacts, and the economic and recreational potential of the Living Breakwaters as well as bring these benefits to the Tottenville community now. It is critical that Phase I be implemented at a scale large enough to be a true proof-of-concept and enable this to become a replicable strategy. The Tottenville project will also allow us to analyze other potential impacts and refine a replicable pathway for scaling-up implementation. Community engagement, regulatory approvals, data collection, and design refinement are all part of the critical next steps to advancing the pilot project.



TOTTENVILLE PHASE I PILOT:

COSTS

\$51 M physical infrastructure costs

\$2.7 M ecological infrastructure costs

\$4 M social infrastructure costs

\$12 M maintenance costs

BENEFITS

\$263 M of damages avoided

52 acres of habitat created

32+ species supported by the breakwaters

\$15 M of potential economic generation annually

550 students engaged directly annually

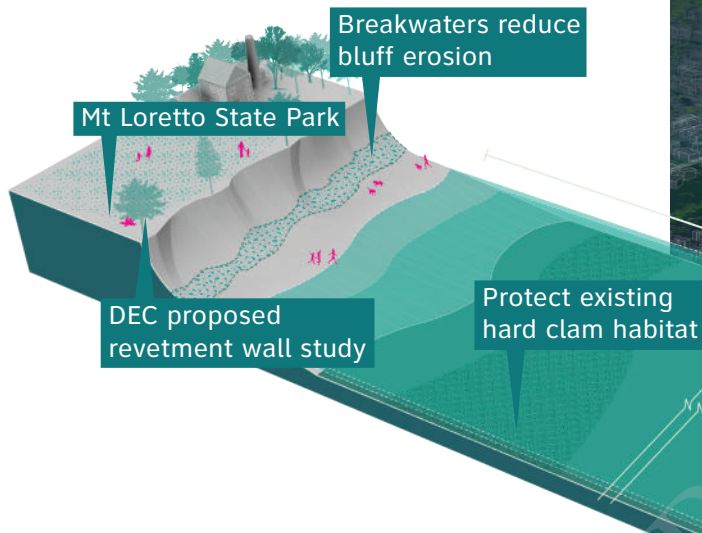
23,500 students engaged island-wide annually

//

Raritan Bay is a
sportsfishing
nexus!

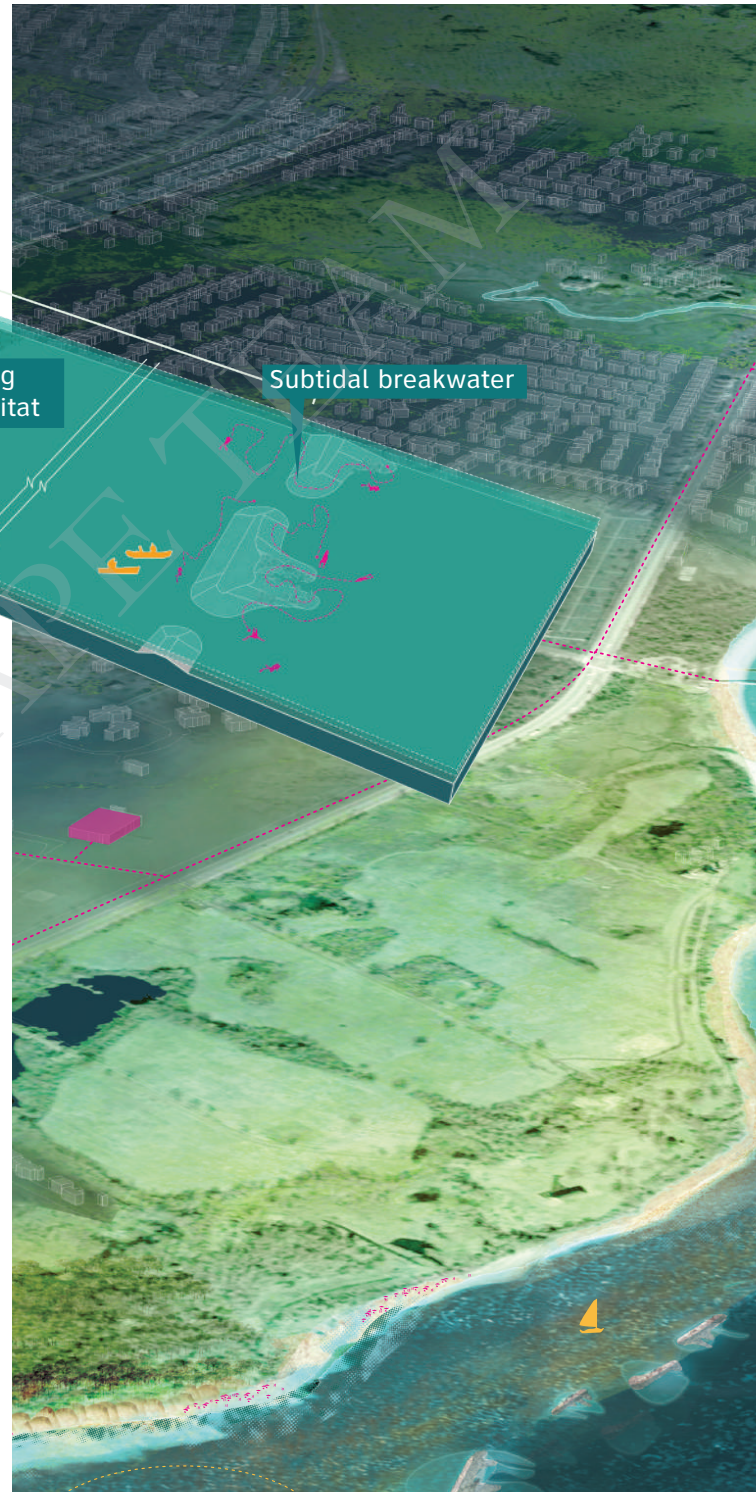
- NOAA Employee

//



MT. LORETTO STATE PARK

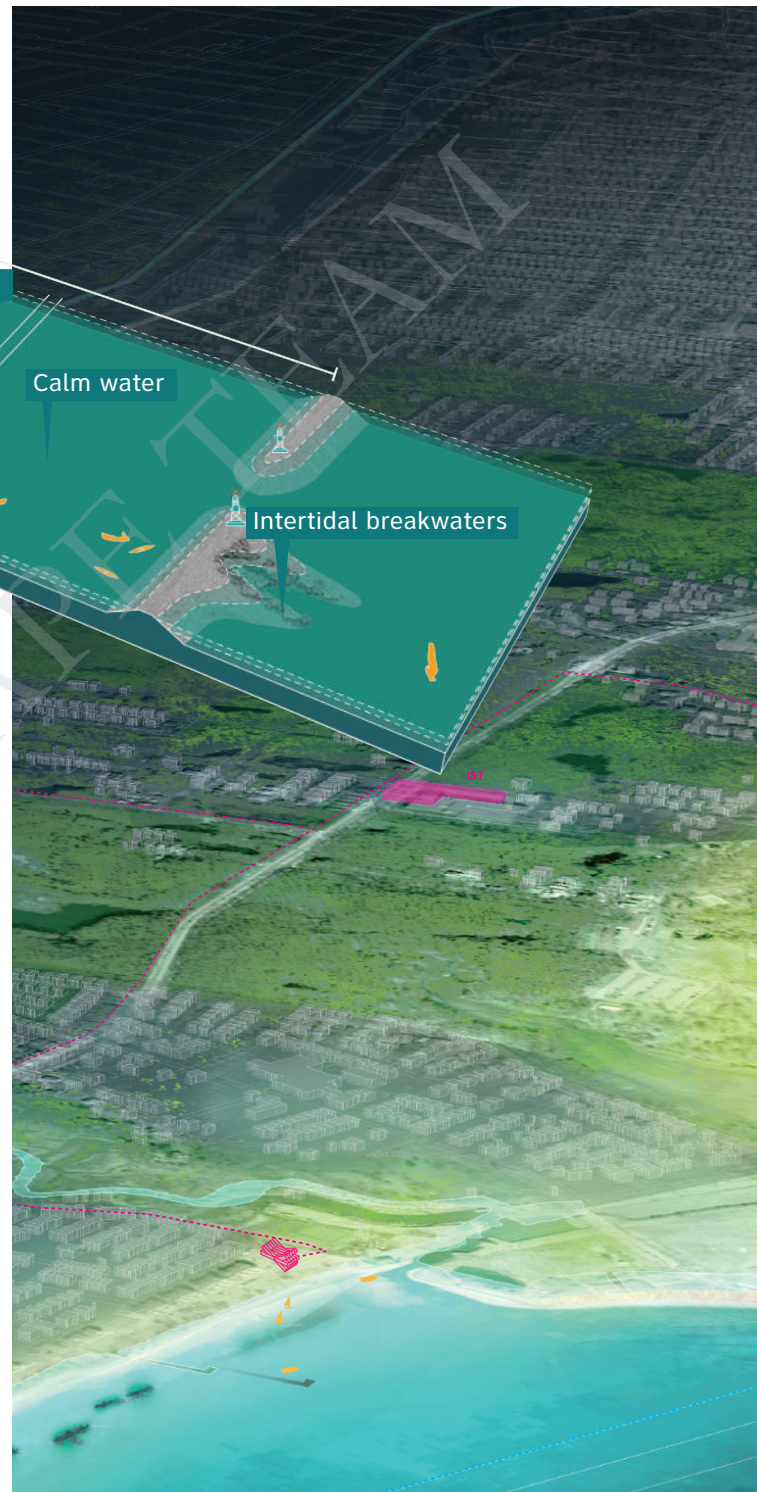
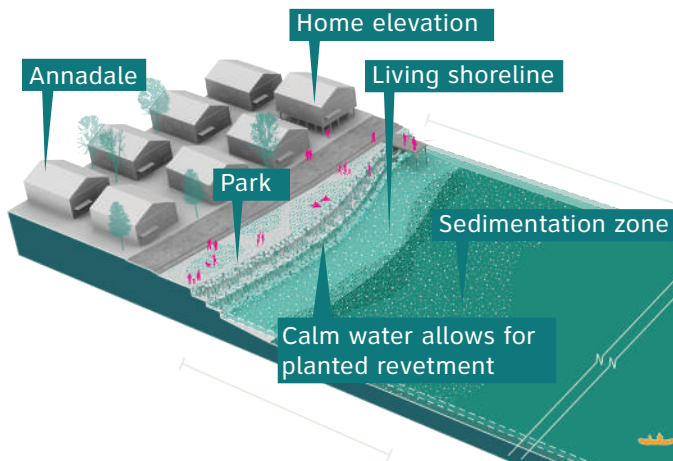
Constructed reefs (subtidal breakwaters) add a layer of risk reduction to sensitive ecosystems without compromising existing ecological vitality. Reducing everyday wave action, constructed reefs have a narrow footprint and are located to minimize sedimentation. At Mt. Loretto, the exposed bluff is quickly eroding, placing critical upland grassland habitat at risk. A layered subtidal constructed reef would slow this erosion, while creating new underwater habitat and State park resources for low-impact enjoyment.





“
I go diving at high
slack tide when the
water is clearest.
- S.I. Sportsdiver
”

ENABLE NEW EDGES



ANNADALE ANDC RESCENBEACH

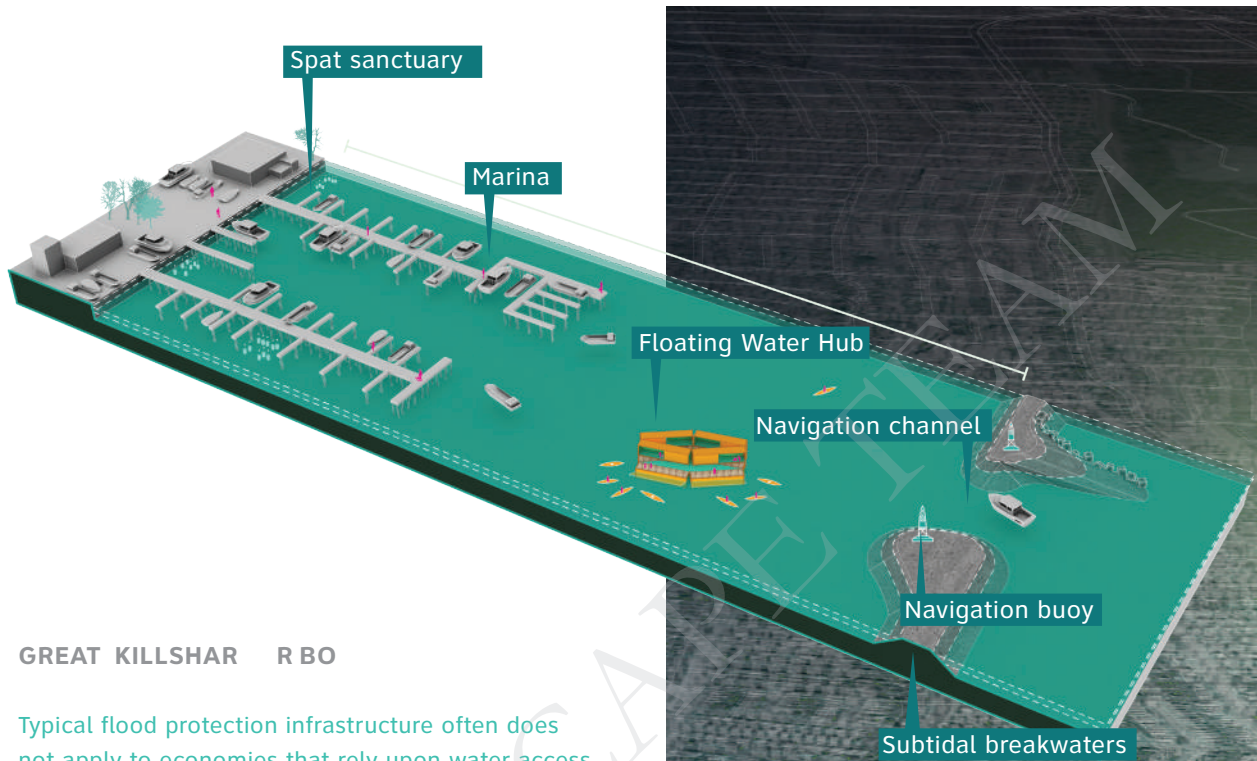
Nearshore breakwaters can enable new occupations and uses of the waterfront, as the reduction of wave action can reduce the height of on shore walls or bulkheads and enable low wave energy ecosystems to thrive. At Annadale, an existing concrete seawall failed during Sandy, collapsing into the ocean. The **LAYERED APPROACH** creates a calmer shoreline condition, enabling new waterfront occupations, innovation in edge construction, and a stronger and more protected edge.



// Oysters are an attractive nuisance and pose significant human health threats. Restoration sites need to be carefully monitored.

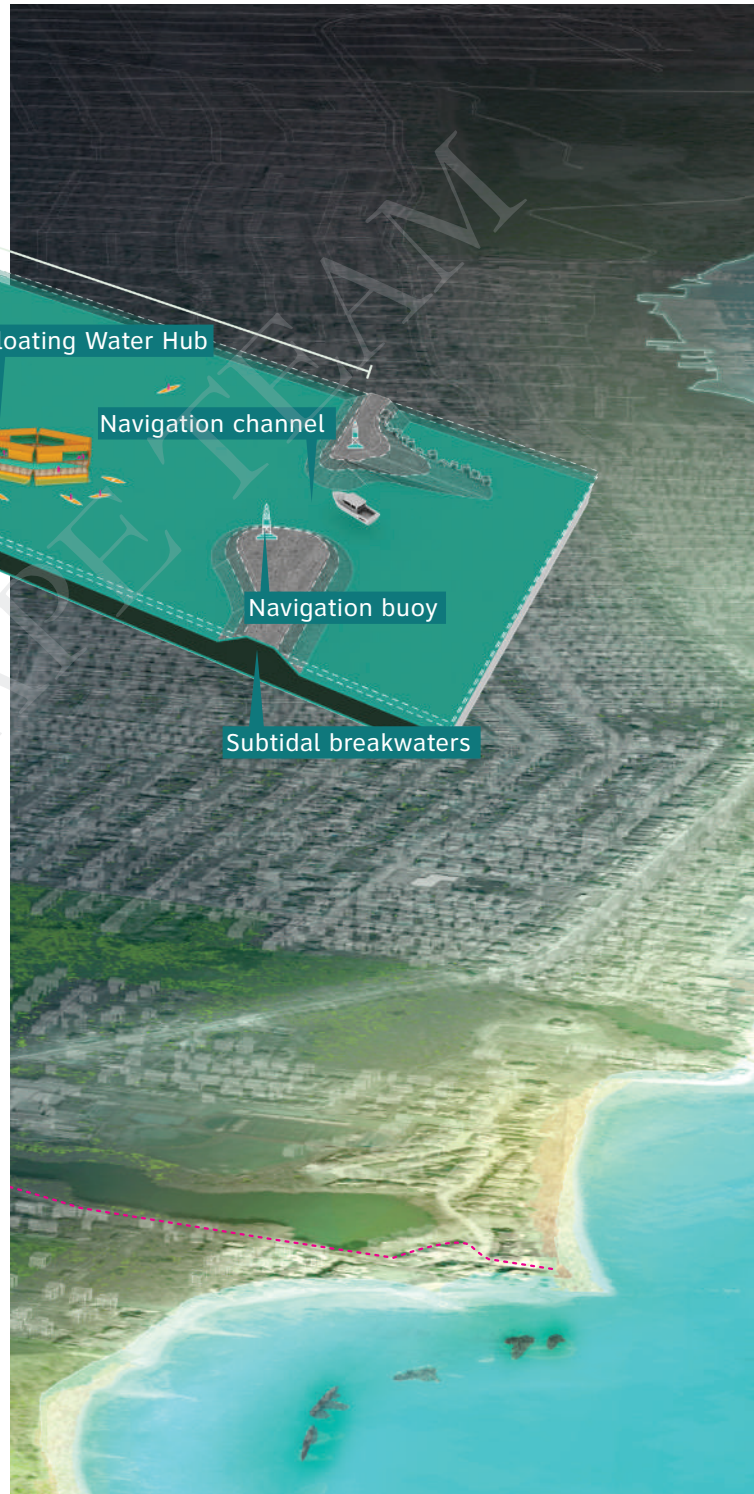
- DEC Employee





GREAT KILLSHAR RBO

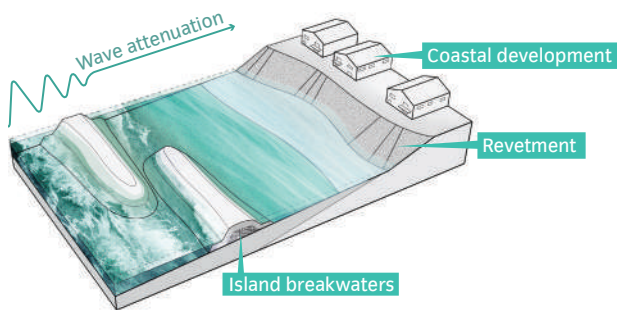
Typical flood protection infrastructure often does not apply to economies that rely upon water access. Living breakwaters can reduce wave action and water velocity damage to marinas and other water-based structures along the shore. Constructed reefs create new finfish and lobster habitat, enhancing recreational fisheries and the local water-based economy.



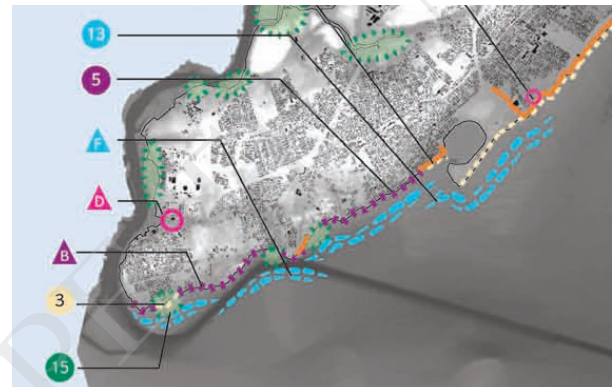


BUILDING ON EXISTING INITIATIVES

The Living Breakwaters project is coordinated with City and State rebuilding initiatives and harbor-wide restoration frameworks and adds a layer of protection that compliments and enhances on-shore upgrades



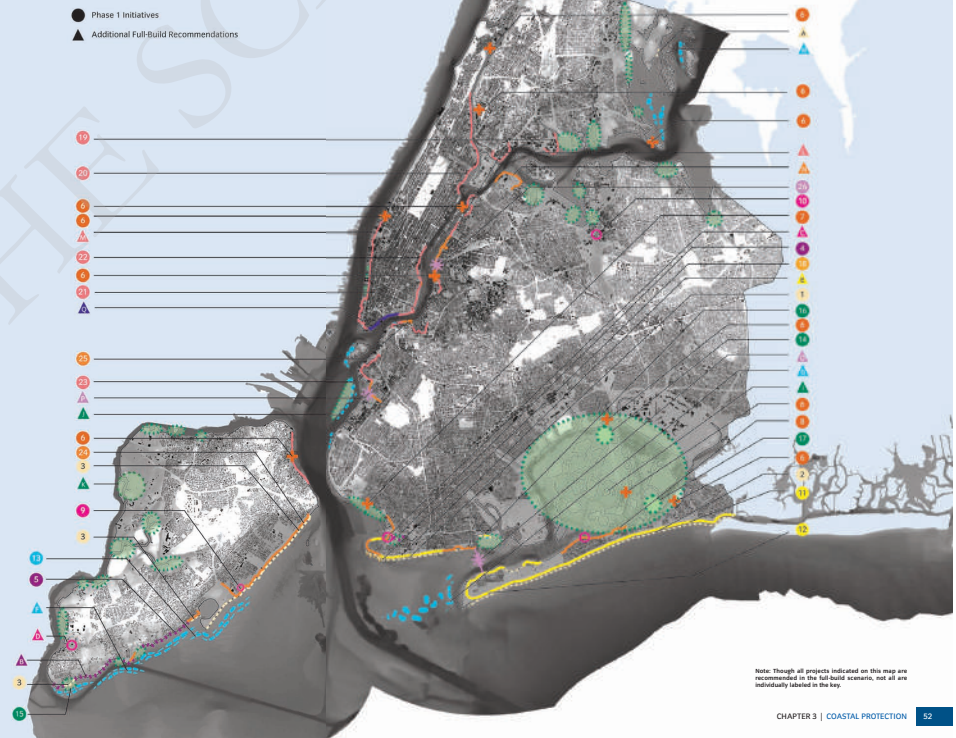
SIRR REPORT



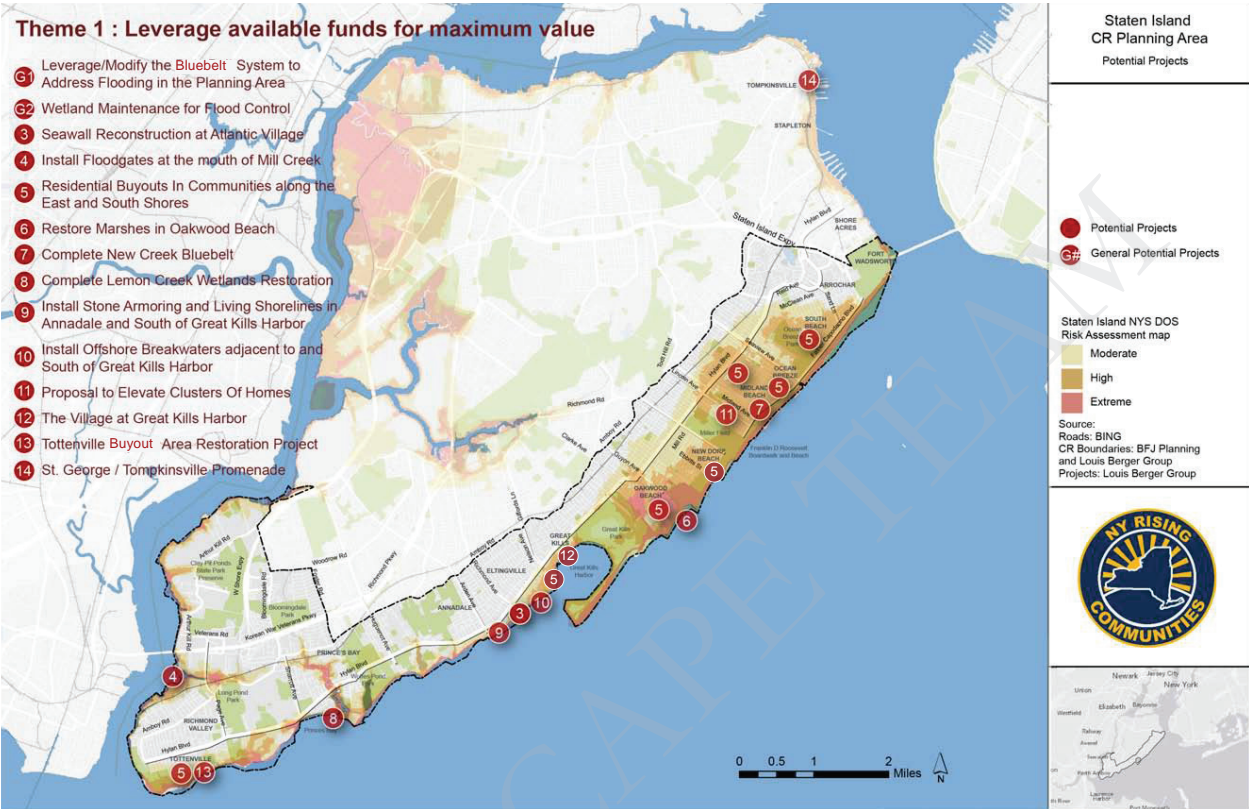
[HTTP://WWW.NYC.GOV/HTML/SIRR/HTML/REPORT/REPORT.SHTML](http://www.nyc.gov/html/sirr/html/report/report.shtml)

Comprehensive Coastal Protection Plan | Full-Build Recommendations

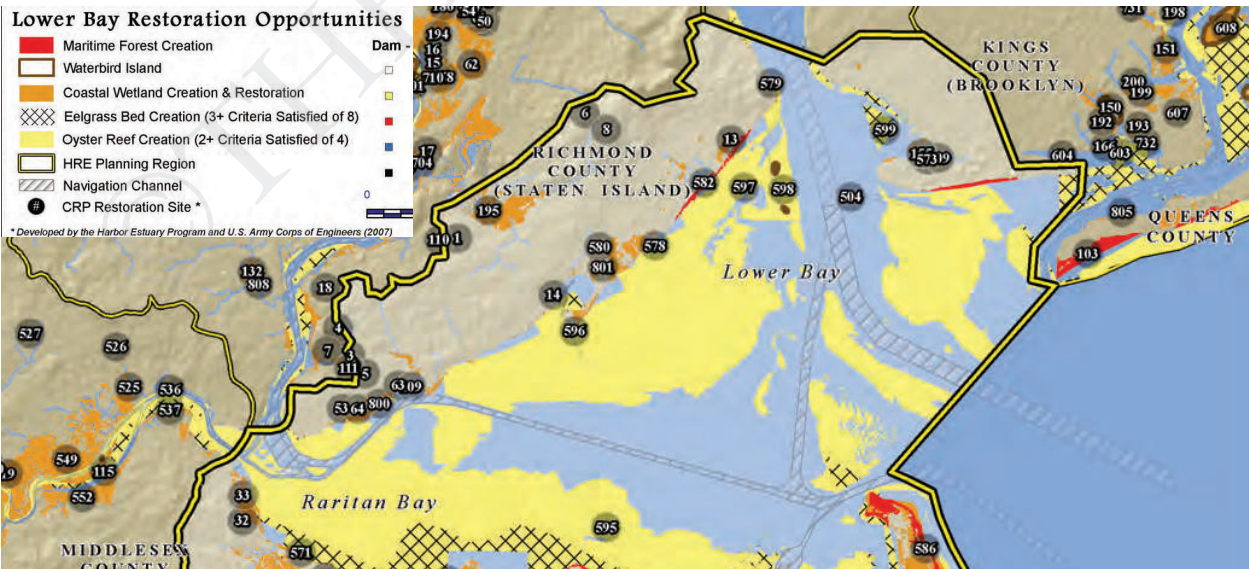
- Increase Coastal Edge Elevations**
 - Beach Nourishment
 - Coney Island, Brooklyn
 - Rockaway Peninsula, Queens
 - East and South Shores, Staten Island
 - Orchard Beach, Bronx
 - Armor Stone (Revetments)
 - Coney Island Creek, Brooklyn
 - Annisdale, Staten Island
 - South Shore, Staten Island
 - Bulkheads
 - Citywide Program
 - Belt Parkway, Brooklyn
 - Beach Channel Drive, Queens
 - Tide Gates / Drainage Devices
 - Oakwood Beach, Staten Island
 - Flushing Meadows, Queens
 - Coney Island Creek, Brooklyn
 - Mill Creek, Staten Island
- Minimize Upland Wave Zones**
 - Dunes
 - Rockaway Peninsula, Queens
 - Breezy Point, Queens
 - Coney Island, Brooklyn
 - Offshore Breakwaters
 - Great Kills Harbor, Staten Island
 - South Shore, Staten Island
 - Rockaway Extension
 - City Island, Bronx
 - Wetlands, Living Shorelines and Reefs
 - Howland Beach, Queens
 - Tottenville, Staten Island
 - Plum Beach, Brooklyn
 - Brant Point, Queens
 - Jamaica Bay
 - Bay Ridge Flats
 - Saw Mill Creek, Staten Island
 - Groins
 - Sea Gate, Brooklyn
- Protect Against Storm Surge**
 - Integrated Flood Protection System
 - Hunts Point, Bronx
 - East Harlem, Manhattan
 - Lower Manhattan / Lower East Side
 - Hospital Row, Manhattan
 - Red Hook, Brooklyn
 - Brooklyn-Queens Waterfront
 - West Midtown, Manhattan
 - Floodwalls / Levees
 - East Shore, Staten Island
 - Farragut Substation, Brooklyn
 - Astoria Generating Station, Queens
 - Local Storm Surge Barrier
 - Newtown Creek
 - Rockaway Inlet
 - Gowanus Canal, Brooklyn
 - Multi-purpose Levee
 - Lower Manhattan



NY RISING STATEN ISLAND CONCEPT PLAN



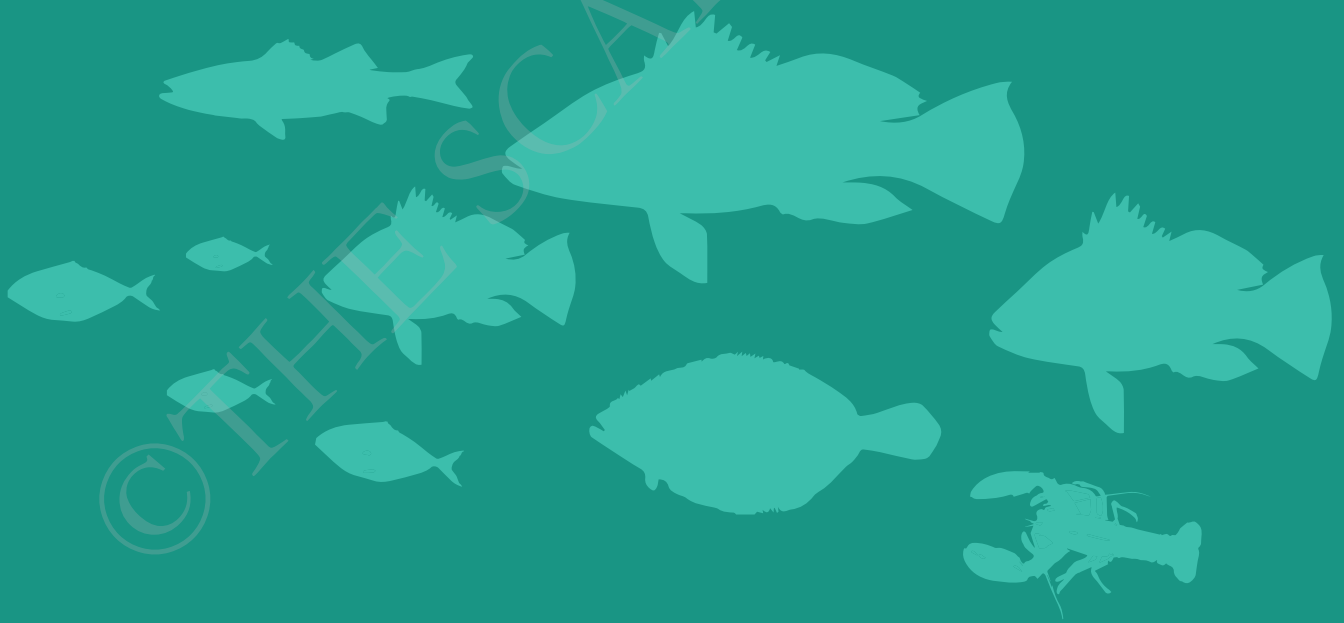
NY / NJ HARBOR COMPREHENSIVE RESTORATION PLAN

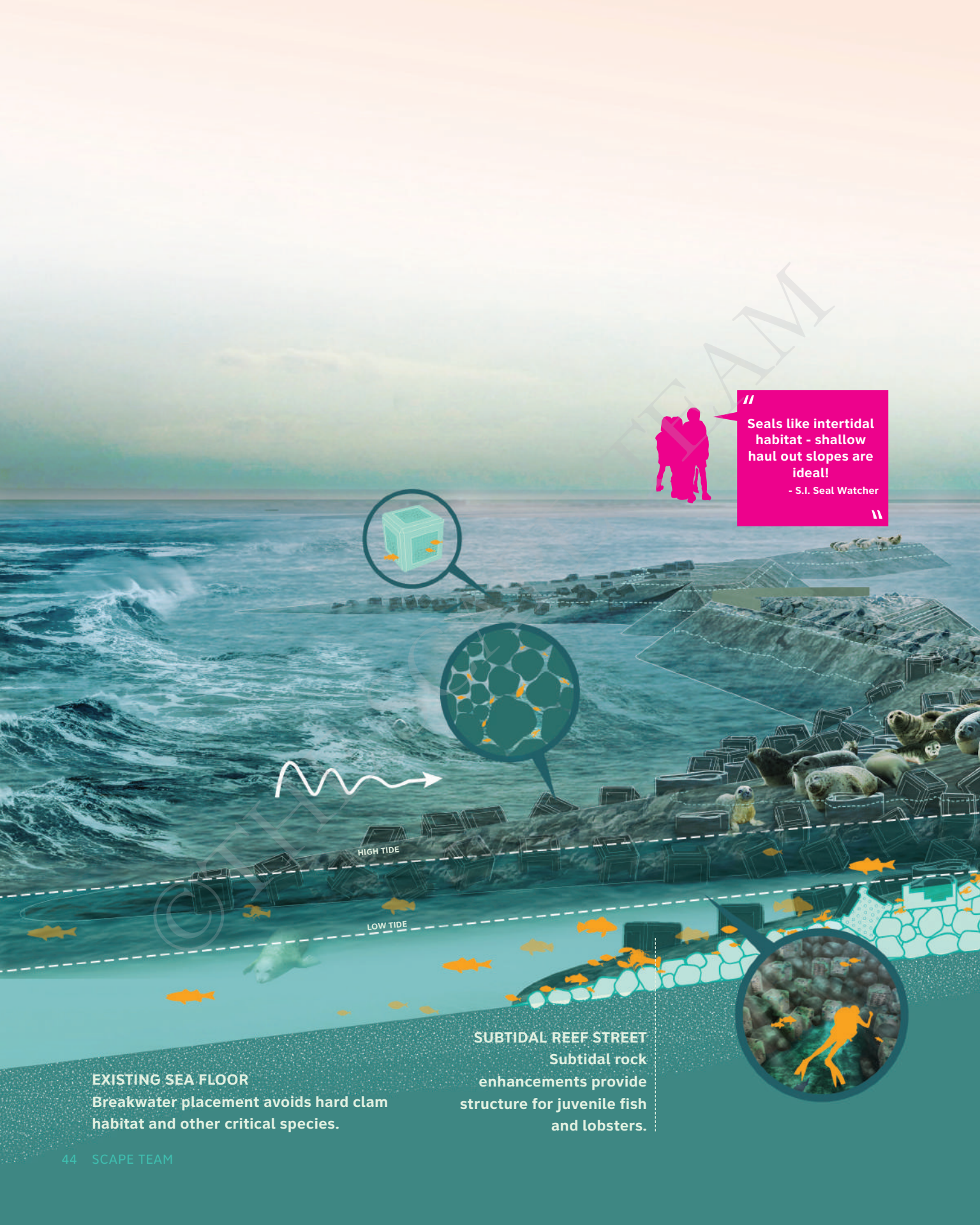


BIOGENIC BUILDUP

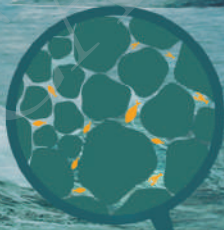


GROWING ECOLOGICAL RESILIENCY





“Seals like intertidal habitat - shallow haul out slopes are ideal!”
- S.I. Seal Watcher



HIGH TIDE

LOW TIDE

EXISTING SEA FLOOR

Breakwater placement avoids hard clam habitat and other critical species.

SUBTIDAL REEF STREET

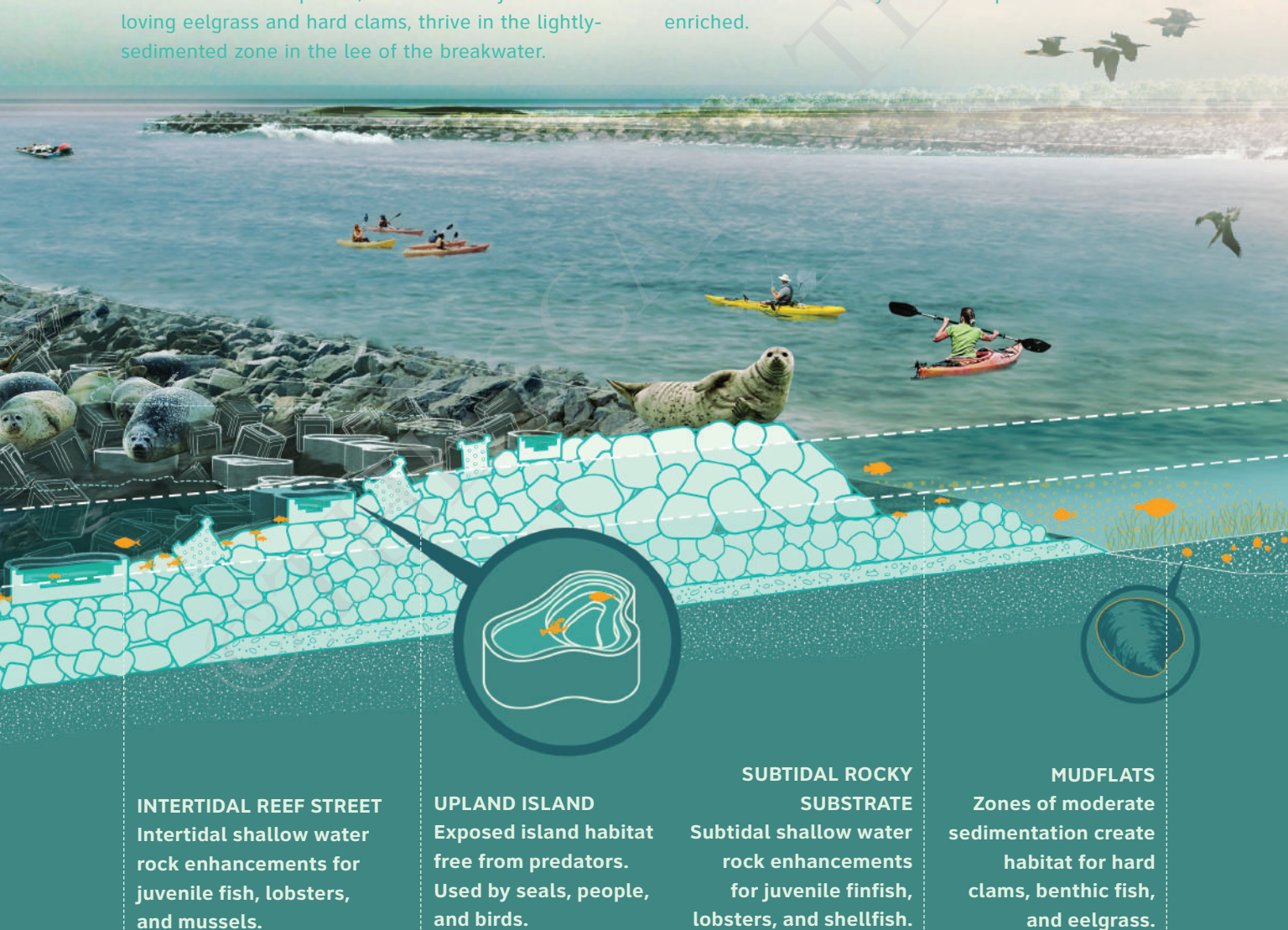
Subtidal rock enhancements provide structure for juvenile fish and lobsters.



GROWING ECOLOGICAL RESILIENCY

Raritan Bay is prime habitat for juvenile fish that shelter in the bay before venturing out into the Atlantic Ocean as adults. Many of these fish species require rocky habitat and tiny pore spaces for shelter during this crucial phase of life. The breakwaters are designed to maximize complexity and habitat for a diversity of species, including finfish, lobsters, and shellfish. Pockets of maximum complexity, known as “reef streets” mimic the historic reef habitats of Raritan Bay while serving as fishing and recreational attractions. Other species, such as muddy bottom-loving eelgrass and hard clams, thrive in the lightly-sedimented zone in the lee of the breakwater.

Harbor seals and birds use the exposed uplands for basking and perching. Econcrete, an innovative low pH concrete mix for maritime construction, is formed into special units that line the reef streets. Their composition of micro- and macro-surface textures is proven to increase biological recruitment and shelter filter-feeding organisms. Ultimately, biogenic buildup will protect the structures from damage and prolong their operational life span. At the same time, water based economies and wildlife viewing opportunities for the local community area are expanded and enriched.



INTERTIDAL REEF STREET

Intertidal shallow water rock enhancements for juvenile fish, lobsters, and mussels.

UPLAND ISLAND

Exposed island habitat free from predators. Used by seals, people, and birds.

SUBTIDAL ROCKY SUBSTRATE

Subtidal shallow water rock enhancements for juvenile finfish, lobsters, and shellfish.

MUDFLATS

Zones of moderate sedimentation create habitat for hard clams, benthic fish, and eelgrass.

DESIGN FOR JUVENILES

Artificial reefs exist offshore of NY and NJ, creating habitat for adult fish. Inside the Raritan Bay, juvenile finfish are a target species group for habitat creation, as they use the bay as a protective living and feeding grounds before venturing into the Atlantic as adults. Our project aims to create subtidal and intertidal reef habitat for juvenile finfish and lobsters in the protective Raritan Bay. Juvenile fish need small holes

and crevices to protect them from larger fish. The breakwater is designed with a range of small crevice spaces found in the piling up of natural stone. These niches are complimented by specific holes formed in ecrete units that line the reef streets.



BLACK SEA BASS
SUMMER / SPRING
ESTUARIES WITH ROUGH BOTTOMS, SHELLFISH AND EELGRASS BEDS, MAIN-IMAGE STRUCTURES SANDY / SHELLY AREAS, OFFSHORE CLAM BEDS AND SMALL PATCHES FOR WINTERING - OYSTER REEFS
3' - 19 CM



SCUP
SUMMER / SPRING
ESTUARIES WITH SANDS, MUD, MUSSEL AND EELGRASS BEDS
STRUCTURE SIZE DEPENDANT ON BODY SIZE - SEEK OUT HOLES THAT FIT BODY 5 CM - 13 CM AS JUV.



BLUEFISH
5-7 MM AS JUVENILES
4-22 MM AS ADULTS
JUVENILES: SANDY BOTTOM HABITATS, ALSO SEA LETTUCE, EELGRASS, AND SPARTINA MARSHES



BUTTERFISH
1.6 - 12 CM JUVENILES
LIVE IN SHELTER OF JELLYFISH
SHALLOW FLATS, SHELTERED BAYS OVER SAND MUD AND ROCK SUBSTRATES



TAUTOG
NEWLY SETTLED TAUTOG IN HABITAT SHALLOW AREAS LESS THAN 1M DEPTH INCLUDING TIDE POOLS
YOUNG TAUTOG - LESS THAN 10 CM JUVENILE - LESS THAN 25 CM
COVER AND VERTICAL RELIEF IMPORTANT - EELGRASS BEDS OYSTER AND CLAM SHELLS USED AS HABITAT FOR YOY AND SMALL BOULDER.



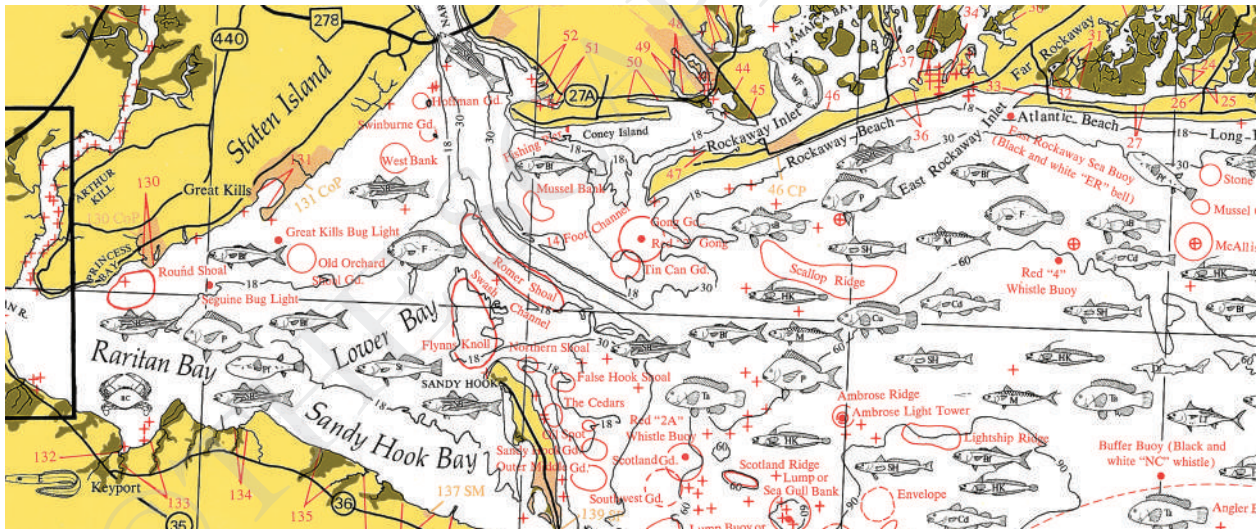
STRIPED BASS
CLEAN, SANDY BOTTOM SHALLOW WATER, GRAVEL BEACHES, SHALLOW WATER NEARSHORE AREAS



LOBSTER
(SIM REQ AS BLACK SEA BASS AND TAUTOG)
JUV - SHALLOW COBBLE SUBSTRATA, 25 MM SIZE WHEN VENTURE FROM SHELTER
COBBLE OR SMALL ROCK - 3-10 CM IN DIAMETER.
LARGER ROCK / BOULDERS 20-40 CM IN DIAMETER.



ATLANTIC STURGEON



CONSTRUCT AROUND THE FISH LIFE CYCLE



SUMMER FLOUNDER
16 CM - 30 CM
SALT MARSH CREEKS, SEAGRASS BEDS, MUDFLATS, OPEN BAY AREAS



WINTER FLOUNDER
BOTTOM HABITATS WITH MUD OR FINE GRAINED SAND



ATLANTIC STURGEON
BOTTOM FEEDERS, SPAWN IN HUDSON, SPEND MOST OF LIFE IN OCEAN

AVOID FLOUNDER MATING SEASON!



JUL



AUG



SEP



OCT



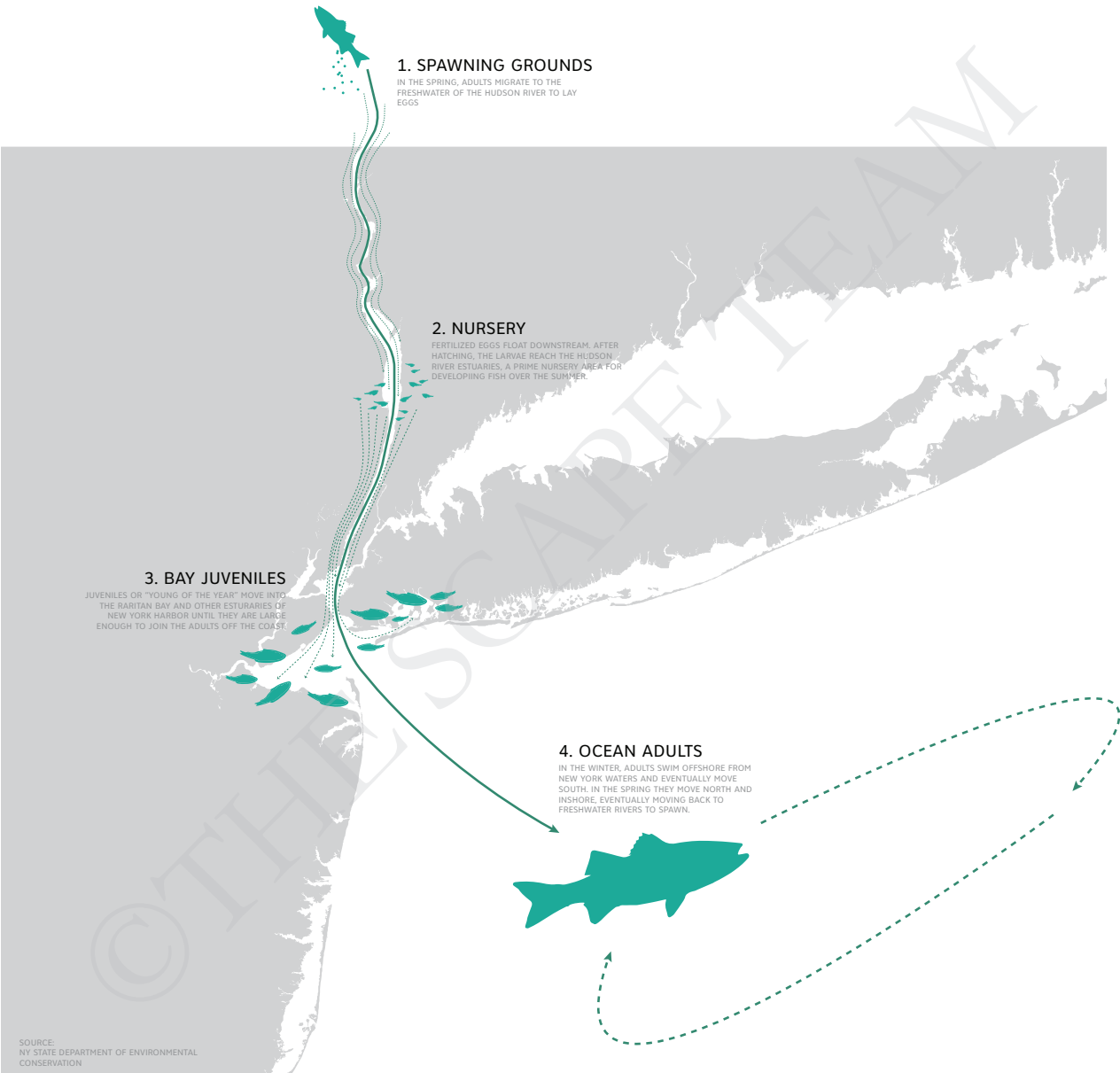
NOV

JUN

DEC

HABITAT LIFE CYCLE

NY/NJ HARBOR

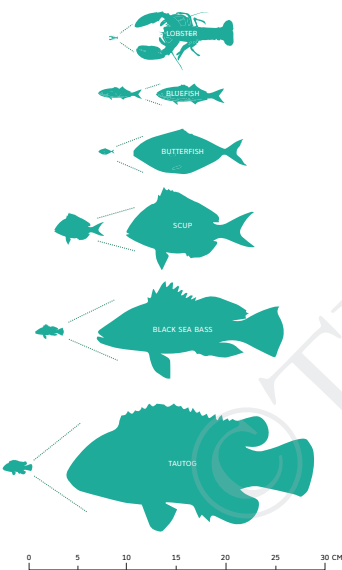


BREAKWATER DESIGN EVOLUTION

Breakwaters are designed to avoid critical habitat and integrate micro-complexity for a diversity of species. The living breakwaters provide habitat throughout the water column, from subtidal structure to upland islands. Underwater, small scale pockets, or reef streets, are incorporated into the breakwater and provide foraging and shelter for juvenile fish. Above water, the breakwaters can host harbor seals and nesting birds, providing habitat free from predators.

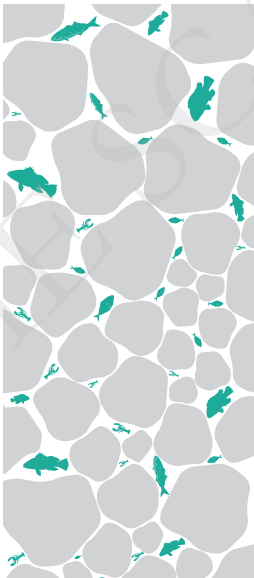
JUVENILE SIZE

FISH AND SHELLFISH SPECIES OF RARITAN BAY WITH PREFERENCE FOR STRUCTURED HABITAT



3 CM - 10 CM ROCK

SMALLER ROCK PROVIDES HABITAT FOR YOUNGER AND SMALLER JUVENILE SPECIES MOST PRONE TO PREDATION.



20 CM - 40 CM ROCK

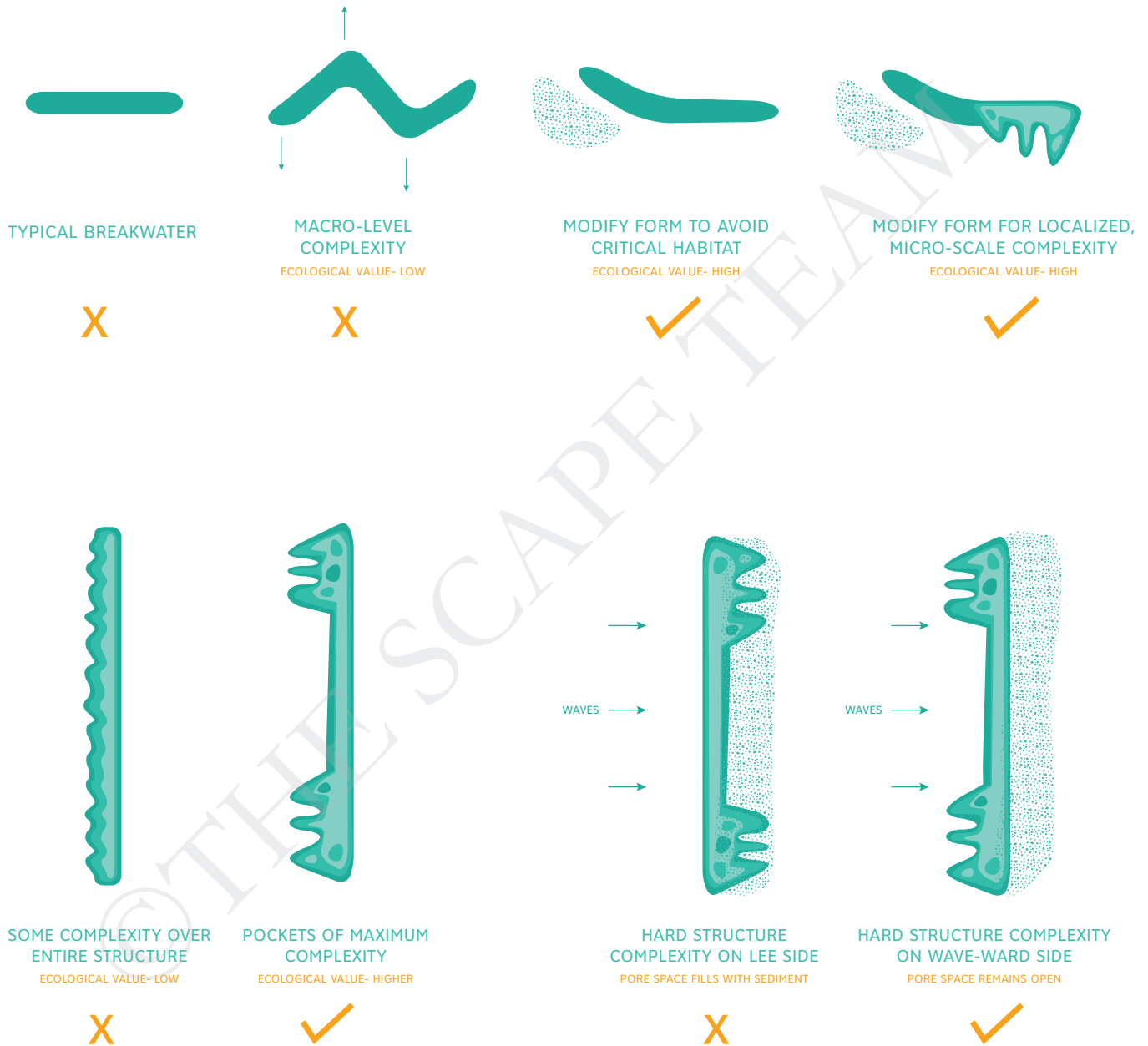
LARGER HOLE SPACES PROVIDE HABITAT FOR JUVENILES AS THEY GROW AND EXPAND THEIR FORAGING RANGE.



OYSTER REEF

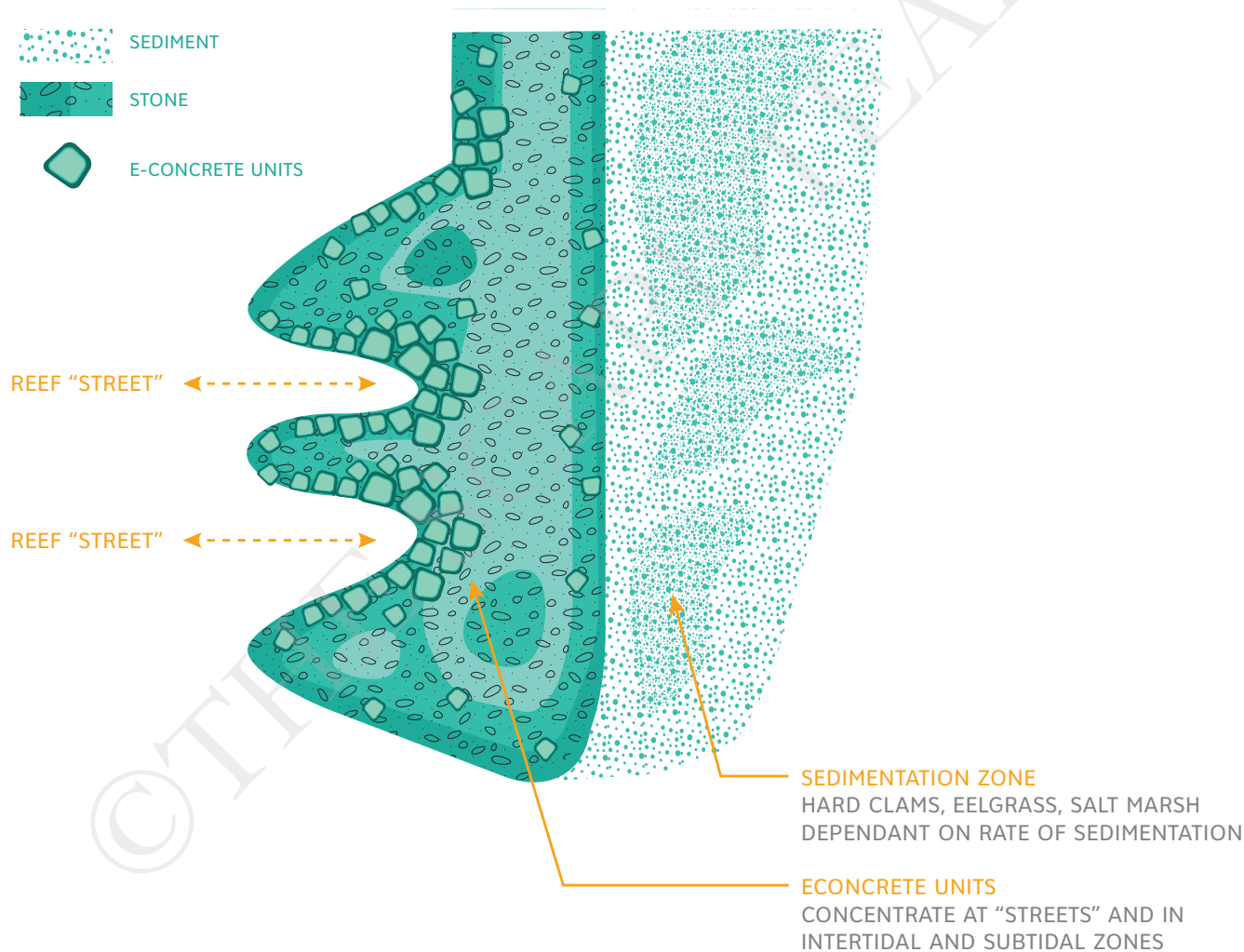
BIOLOGICAL STRUCTURES PROVIDE COMPLEX GEOMETRIES ACCOMMODATING A RANGE OF SPECIES AND AGES.



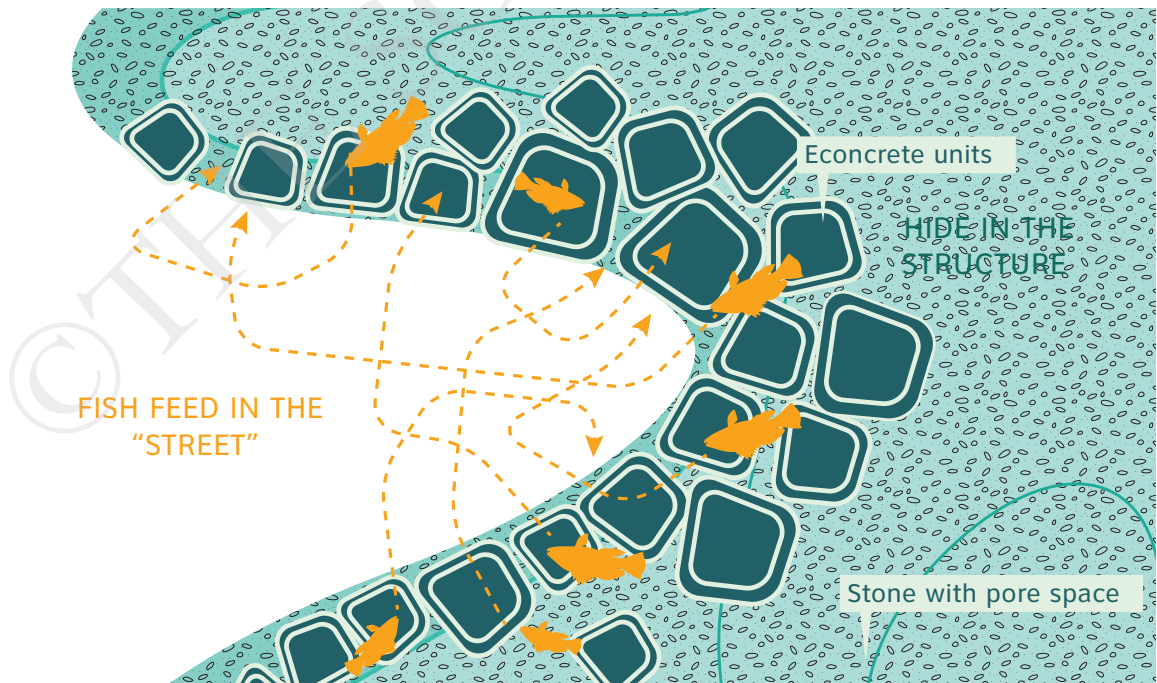
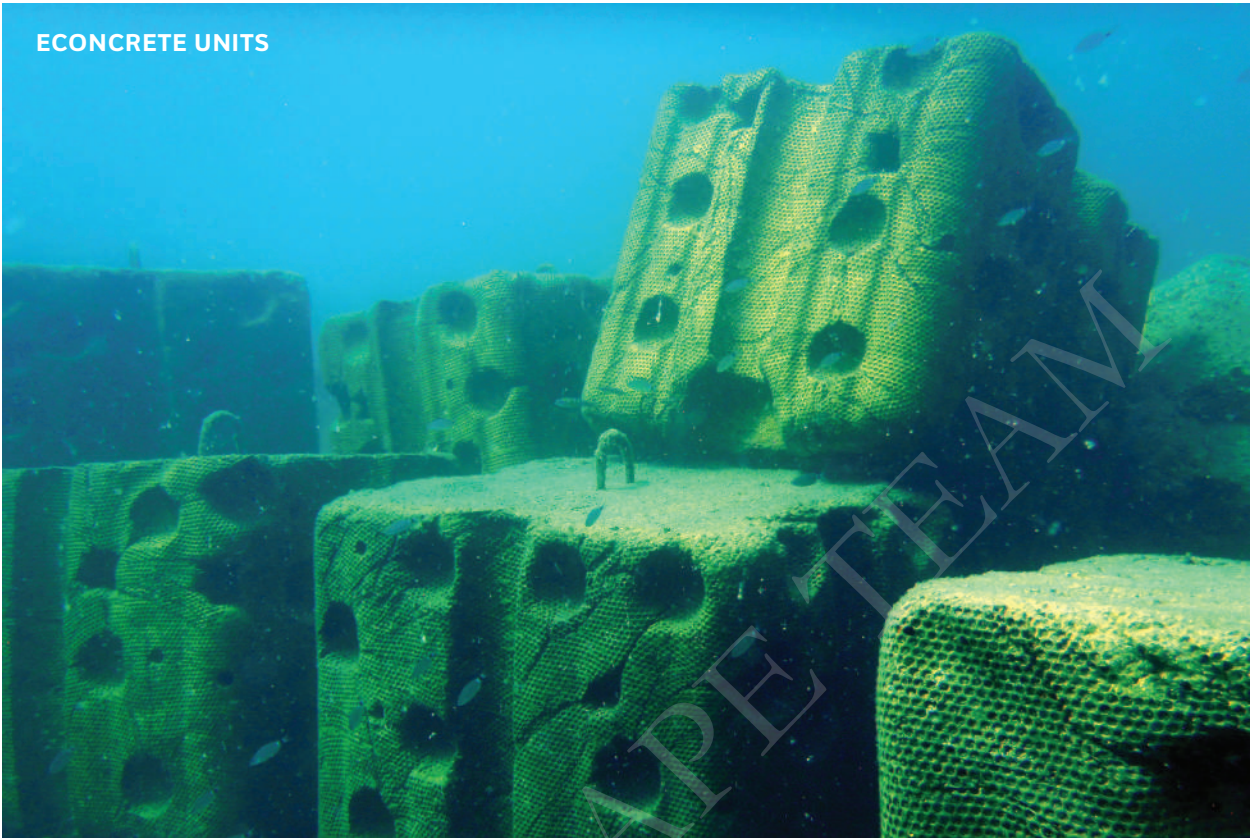


THE REEF “STREET”

Juvenile fish hide from predators in the matrix of econcrete and stone and feed in the narrow waters of the reef streets. This constructed habitat will attract fish of all ages, and in turn, fishermen looking for that perfect secret fishing hole.



ECONCRETE UNITS



ECONCRETE UNITS

Econcrete units will be set with oyster spat (juveniles) and placed in the breakwater reef. Oyster gabions will be tested as part of the living shoreline and breakwater strategy. Tankless setting, an experimental method that releases spat into the water column,

can be tested along the reef streets. Spat sanctuaries will be placed in local marinas and parks with the permission of project partners and will increase the likelihood of natural oyster recruitment throughout the harbor.

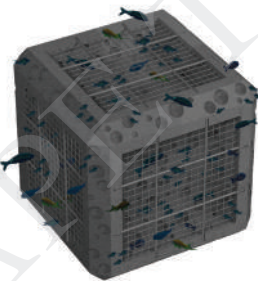
OYSTER HATCHERY UNIT



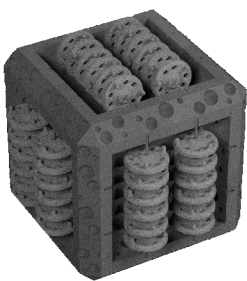
FISH HUB



TIDAL PLANTER

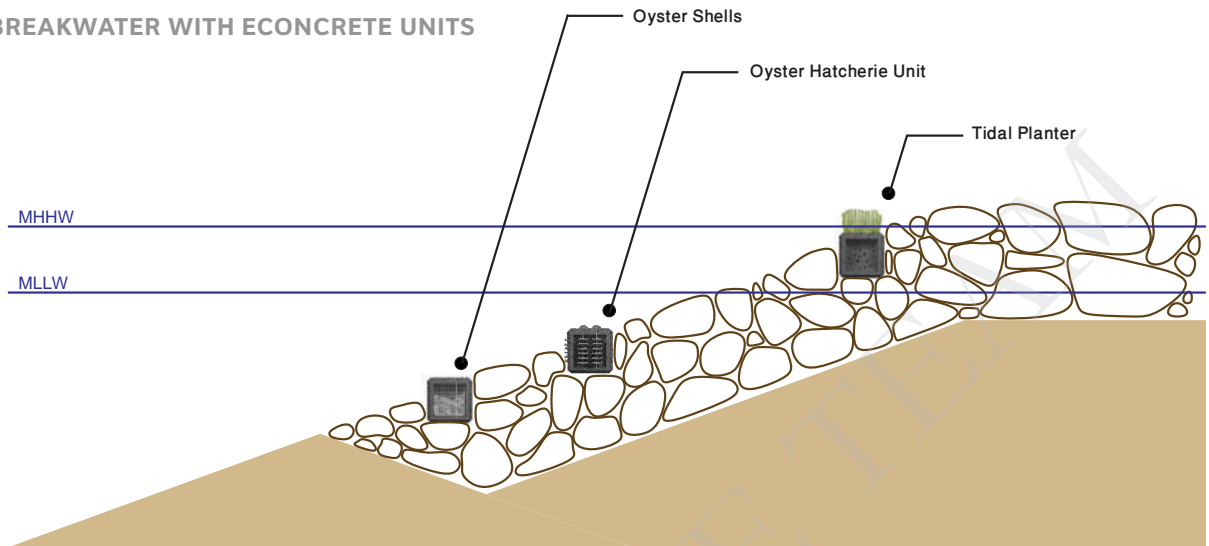


OYSTER SHELLS

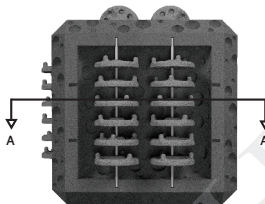


ECONCRETE MATERIAL SAMPLE WITH RECYCLED GLASS AGGREGATE

BREAKWATER WITH ECONCRETE UNITS

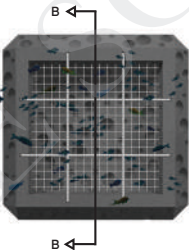


Oyster Hatcherie Unit:



Section AA

Fish Hub:



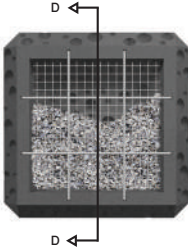
Section BB

Tidal Planter:

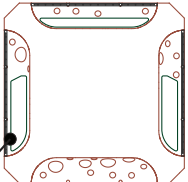
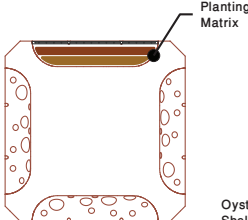
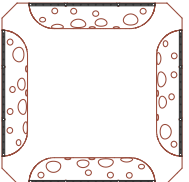
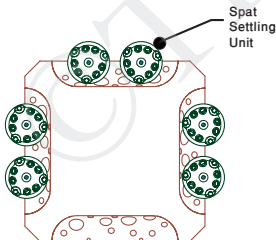


Section CC

Oyster Shells:



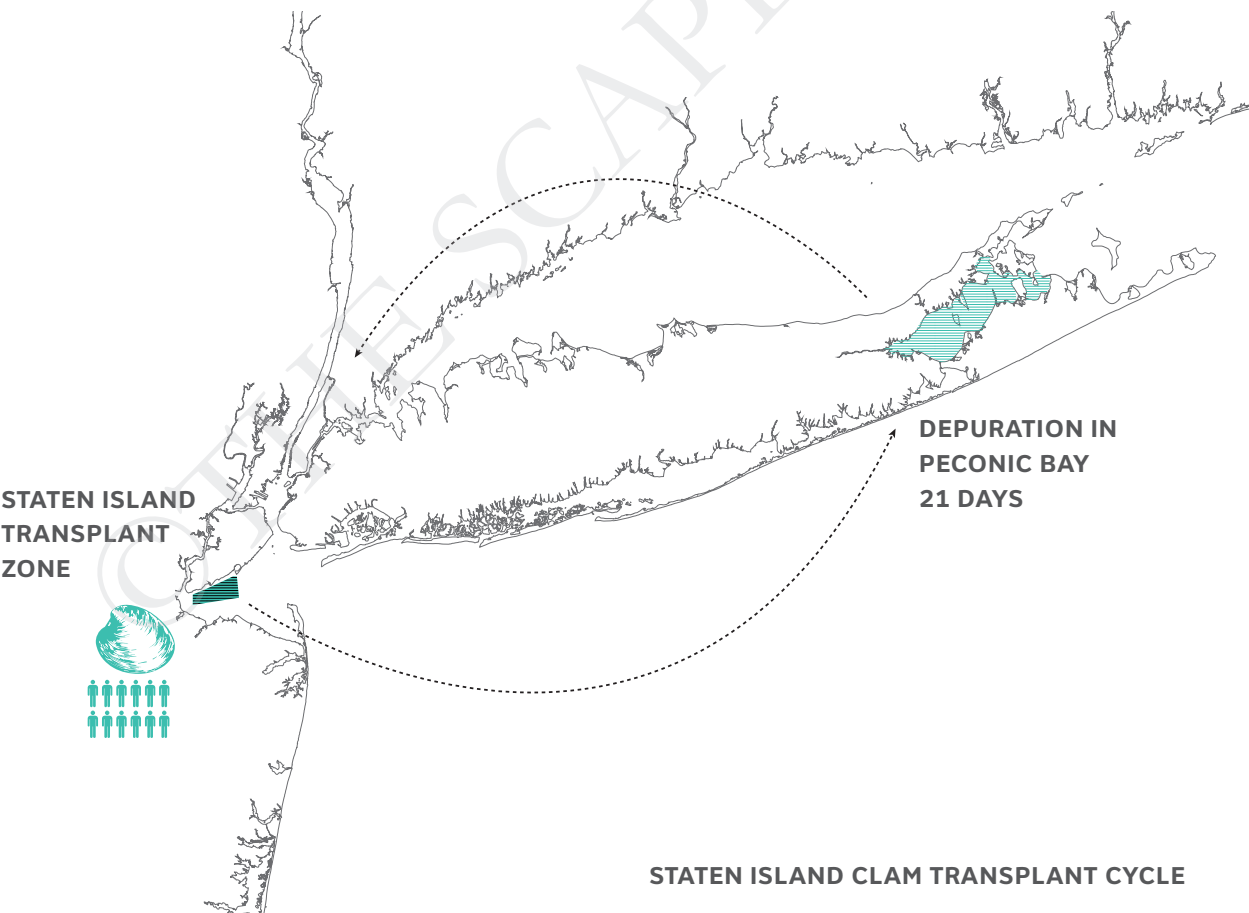
Section DD



5	Project Name:	Breakwater Unit			Sketch Name:	Section View			Comments: - All dimensions are in millimeters. - The sketches on this page are general product plans and are not for production. Engineering and development as well as shop drawings of the products are the sole responsibility of the manufacturer under the supervision of ECOConcrete. - The final dimensions of the product will be determined at the final planning stage. - The manufacturer will provide construction and load calculations as well as detailed production drawings for ECOConcrete's approval.
	Part:				Version:	1	Scale:	1:20	
					Updated:	13-12-2013	Drawn by:	Adi Neuman	
					File Name:	ECOConcrete_BreakwaterUnits_13_12_2013	Approved by:	Ido Bella	
		For Review:	<input checked="" type="checkbox"/>	For Approval:	<input type="checkbox"/>	For Tender:	<input type="checkbox"/>	For Execution:	<input type="checkbox"/>

AVOID CLAM HABITAT DISPLACEMENT

Protecting aquatic habitat and the maritime economy is critical to our proposal. Our team met with a local group of Staten Island clammers to learn more about the link between ecosystems and economies in the active South Shore hard clam transplant zone. The clammers helped us map out zones of hard clam abundance and benthic sediment conditions, helping us align the breakwaters to avoid disturbing this ecosystem. As the project advances, further benthic habitat studies will be needed to avoid damage to the Staten Island clamming economy.





WHAT ABOUT OYSTERS?

Reefs and leased oyster beds once extended across the shallow water flats of Raritan Bay, reducing storm impacts and filtering water. Our project incorporates oyster restoration as one of many critical habitats of the breakwater design. We propose the use of multiple techniques - from oyster gardens to spat on econcrete units - to restore oysters to the Raritan Bay in a measured and monitored way. Along with filtering the water, oysters biogenically build along with the threat of climate change to increase the strength of the protective breakwater system.



OPPORTUNITIES

ADVANCE RESTORATION OF HISTORIC AND CULTURALLY RELEVANT ECOSYSTEMS

GROW ALONG WITH THE THREAT OF CLIMATE CHANGE

ADVANCE THE COMPREHENSIVE RESTORATION PLAN GOALS

IMPROVE WATER QUALITY

EDUCATIONAL TEACHING TOOL

KEYSTONE SPECIES - BUILD DIVERSITY

ADVANCE RESTORATION SCIENCE

CONCERNS

ATTRACTIVE NUISANCE AND THREAT TO HUMAN HEALTH AND SAFETY

POTENTIAL DISPLACEMENT OF EXISTING HABITAT

LONG TERM VIABILITY

OYSTER REEF INCORPORATED INTO LIVING BREAKWATER

OYSTER REEF

EASTERN
OYSTER

CLEAN WATER

EXCESS
NUTRIENTS

+ ONE EASTERN OYSTER
(*CRASSOSTREA VIRGINICA*)
FILTERS 50 GALLONS OF WATER A
DAY. OYSTER REEFS ACCRET
INTO GROWING, ADAPTIVE
COASTAL STRUCTURES THAT CAN
BE HARNESSSED FOR RESILIENCY
AND GROW TO ADAPT TO SEA
LEVEL RISE.

+ OYSTERCATCHERS

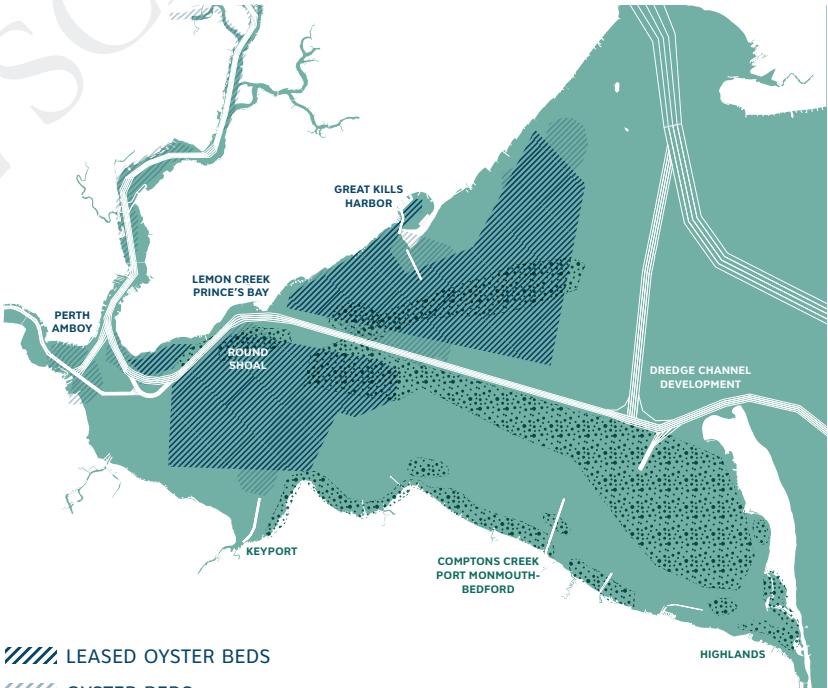
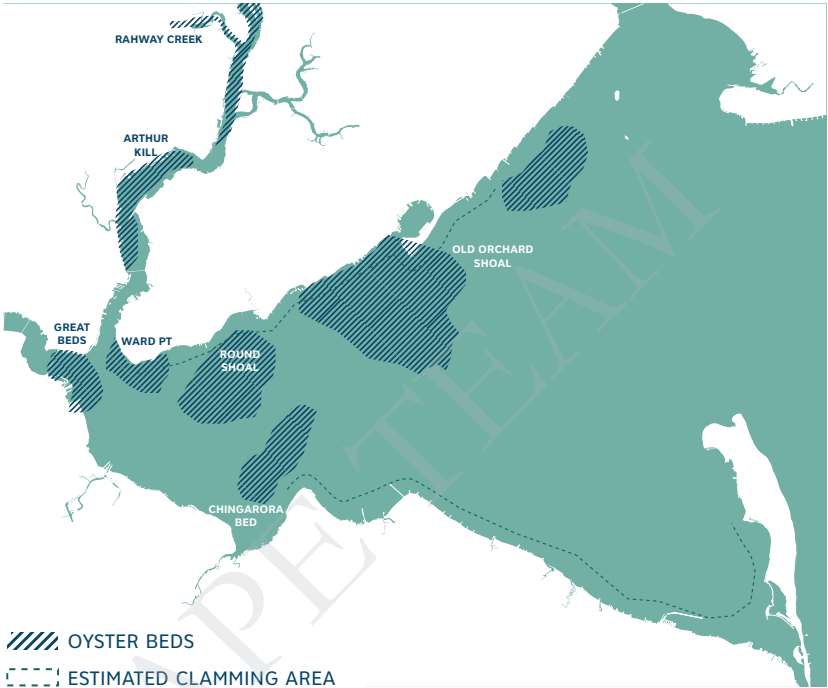
THE HISTORY OF THE OYSTER AND CLAM INDUSTRY IN RARITAN BAY



1800-1850S

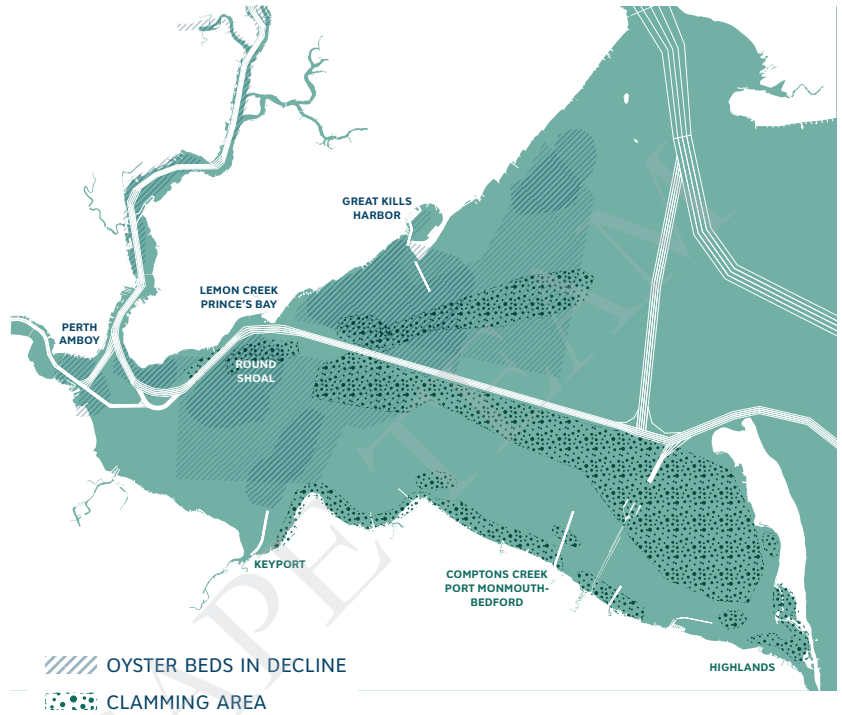


1850s-1900

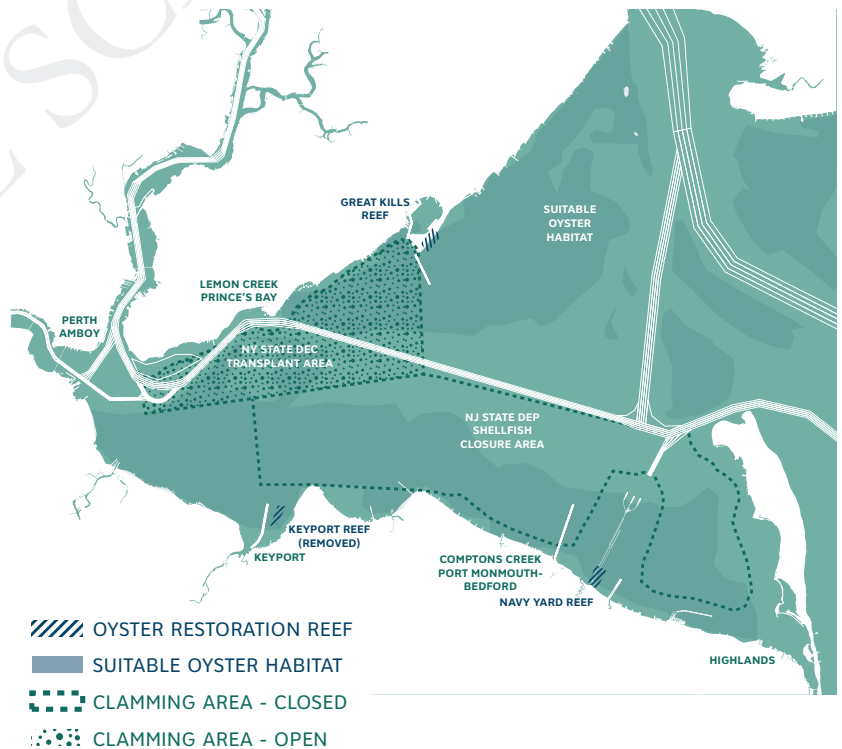




1900S-1950S



1950S-TODAY



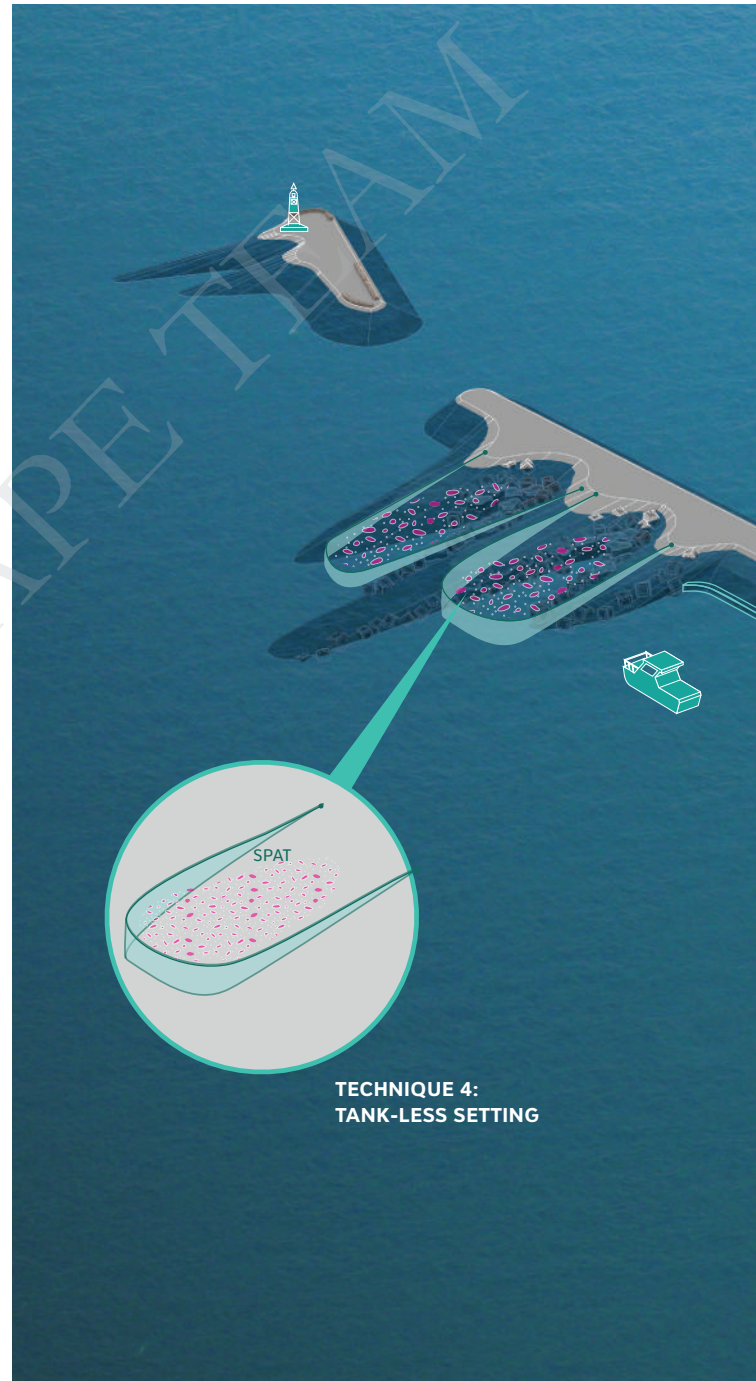
OYSTER RESTORATION TECHNIQUES

We propose to integrate shellfish restoration into the design using multiple techniques – some previously tested in the Harbor, some experimental. The suggested restoration techniques range from oyster gardens to spat on econcrete units and help to restore oysters to the Raritan Bay in a measured and monitored way.

Econcrete units will be set with oyster spat (juveniles) and placed in the breakwater reef. Oyster gabions will be tested as part of the living shoreline and breakwater strategy. Tankless setting, an experimental method that releases spat into the water column, can be tested along the reef streets. Spat sanctuaries will be placed in local marinas and parks with the permission of project partners and will increase the likelihood of natural oyster recruitment throughout the harbor.



SPAT SANCTUARY WITH FLOATS MOORED TO MARINA PIERS.



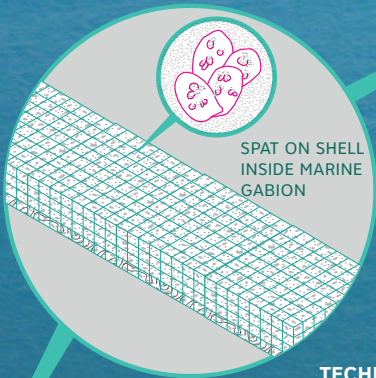


//
**What about
oysters?**
- S.I. Resident
\\

LIVING SHORELINE

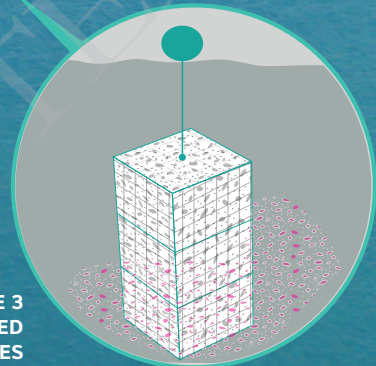
MARINE PIERS

LIVING SHORELINE



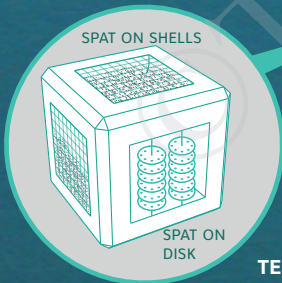
SPAT ON SHELL
INSIDE MARINE
GABION

**TECHNIQUE 2:
OYSTER GABION
SUBTIDAL UNITS ONLY**



TECHNIQUE 3

**SPAT SANCTUARY WITH FLOATS MOORED
TO MARINE PIERS AT MONITORED SITES**



SPAT ON SHELLS

SPAT ON
DISK

**TECHNIQUE 1
ECONCRETE OYSTER DISK
ATTACHED TO SUBTIDAL UNITS ONLY**



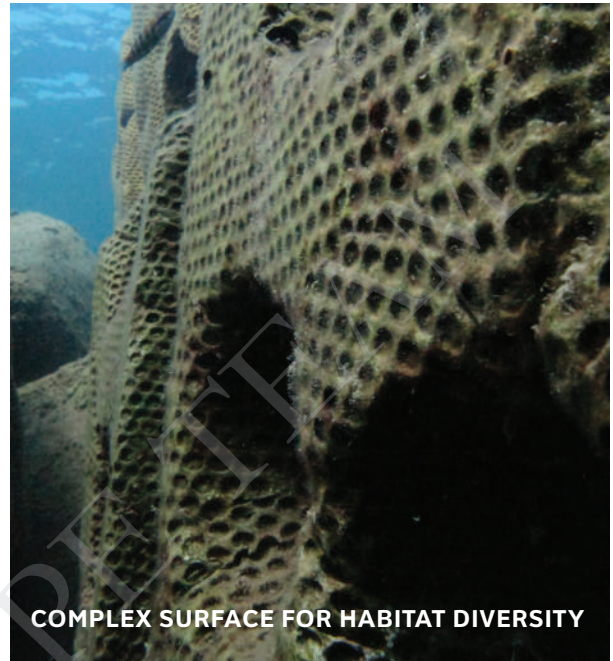
OYSTER CAM



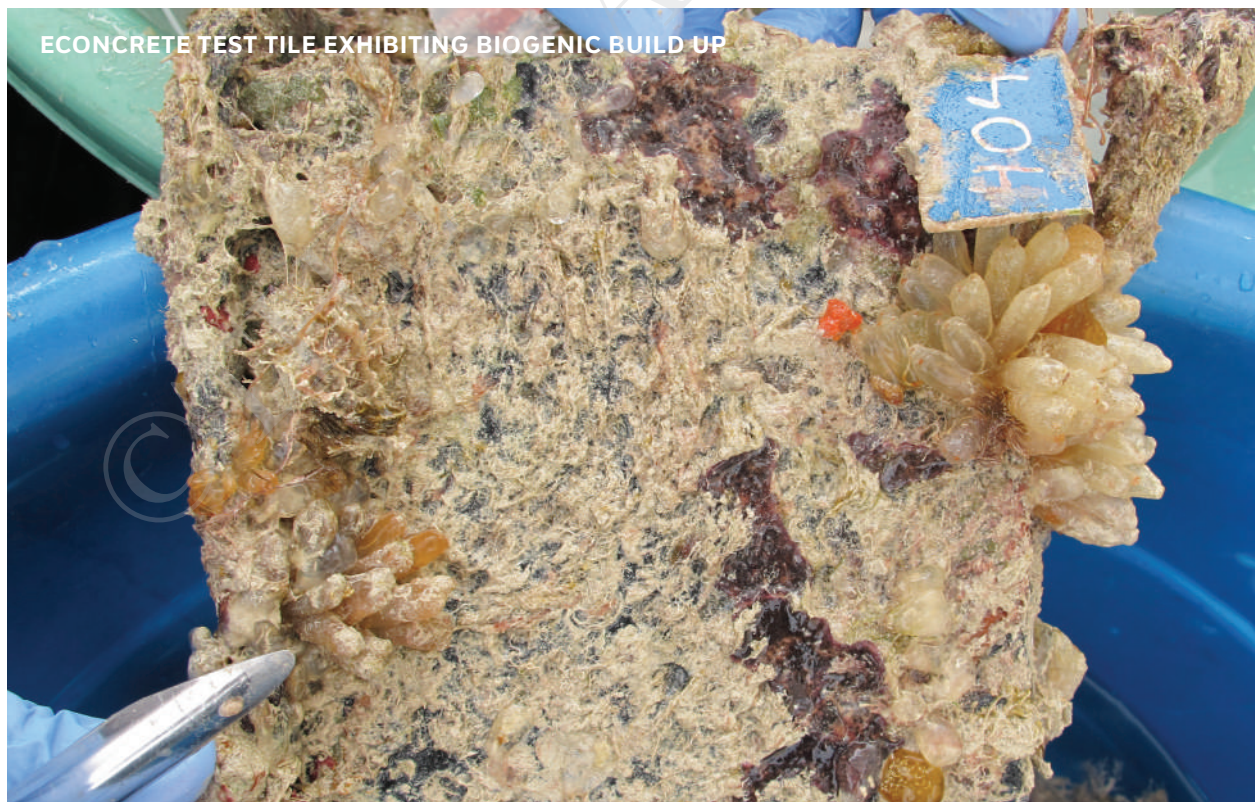
**NAVIGATIONAL GUIDE AND
MONITORING CAMERA TO
PREVENT POACHING**

BIOGENIC BUILD UP

It is critical to explore the restoration of oysters and other species that biogenically build reef systems, as these species can grow along with the threat of climate change, while increasing the strength of the protective breakwater system. Biogenic buildup is the agglomeration of multiple marine species on the face of an underwater structure. The shells of these organisms not only create a thriving ecosystem, but layer over time to create a calcified natural surface over top the man-made structure below. Marine growth can contribute to enhanced strength, stability, and longevity of breakwaters - thus reducing the need for maintenance



COMPLEX SURFACE FOR HABITAT DIVERSITY

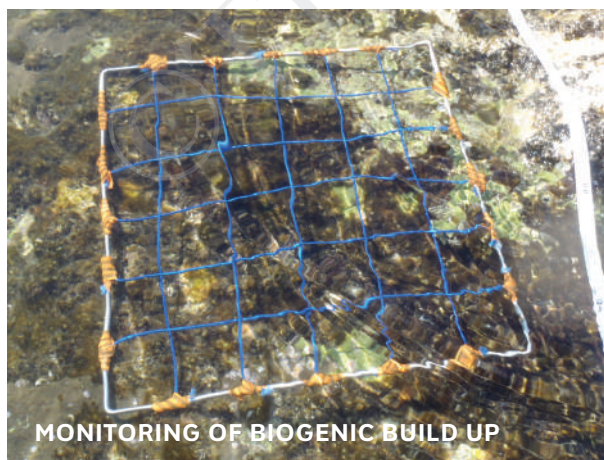


ECONCRETE TEST TILE EXHIBITING BIOGENIC BUILD UP

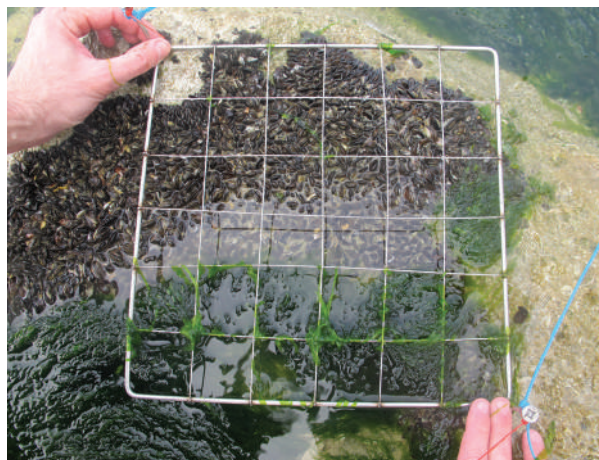
SOUND VIEW REEF RESTORATION, BRONX



Monitoring of the ecosystem can be conducted in concert between scientists, students, and citizen scientists within the community.



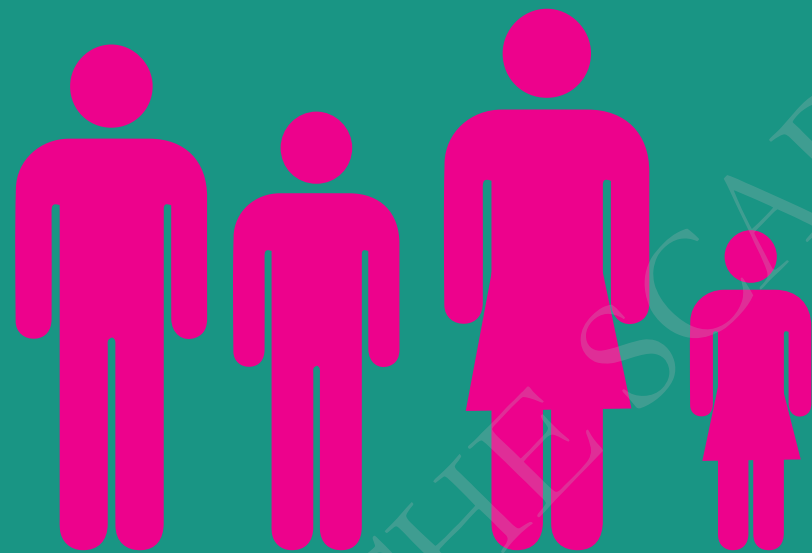
MONITORING OF BIOGENIC BUILD UP





REEF MODEL BUILDING WORKSHOP

BUILDING SOCIAL RESILIENCY



BUILDING SOCIAL RESILIENCY



Staten Islanders can reconnect to the coast through a network of highly visible and programmed Water Hubs which will become places that foster social cohesion and provide orientation, information, storage space, and group gathering spaces. The hubs are to be designed through community design charrettes where programs and needs are identified and incorporated into the structures. Each site condition and community need creates a different type of hub – embedded, floating, cantilevered, or elevated. At Tottenville, pictured here at right, potential water-hub programs include community

kayak storage suggested by Kayak Staten Island, wet-lab science tools for use by Tottenville High School, and bird-and-seal-watching platforms replacing those lost at Conference House Park during the storm. These programs, combined with amenities such as bathrooms and water fountains, vastly expand the age range and experience level for water-based activities available to residents. The Water Hub acts as a “lighthouse,” a beacon of orientation, and bridges the layered dune system below.





POTENTIAL WATER HUB LOCATIONS

The site selection for the Water Hubs is driven by multiple factors: First and foremost, the Water Hub is the on-land component of the Living Breakwaters, therefore it must be located on places where the breakwaters are required, namely flooding prone areas with potential for marine habitat, places where access to the waterfront can be created for the community, and sites where public transportation is within reach. Great Kills, Lemon Creek, Mill Creek and Tottenville in the South of Staten Island were selected for these reasons. Sites will be more rigorously assessed during the following phases addressing questions about the CEHA zone sensitivity and coastal construction permitting.



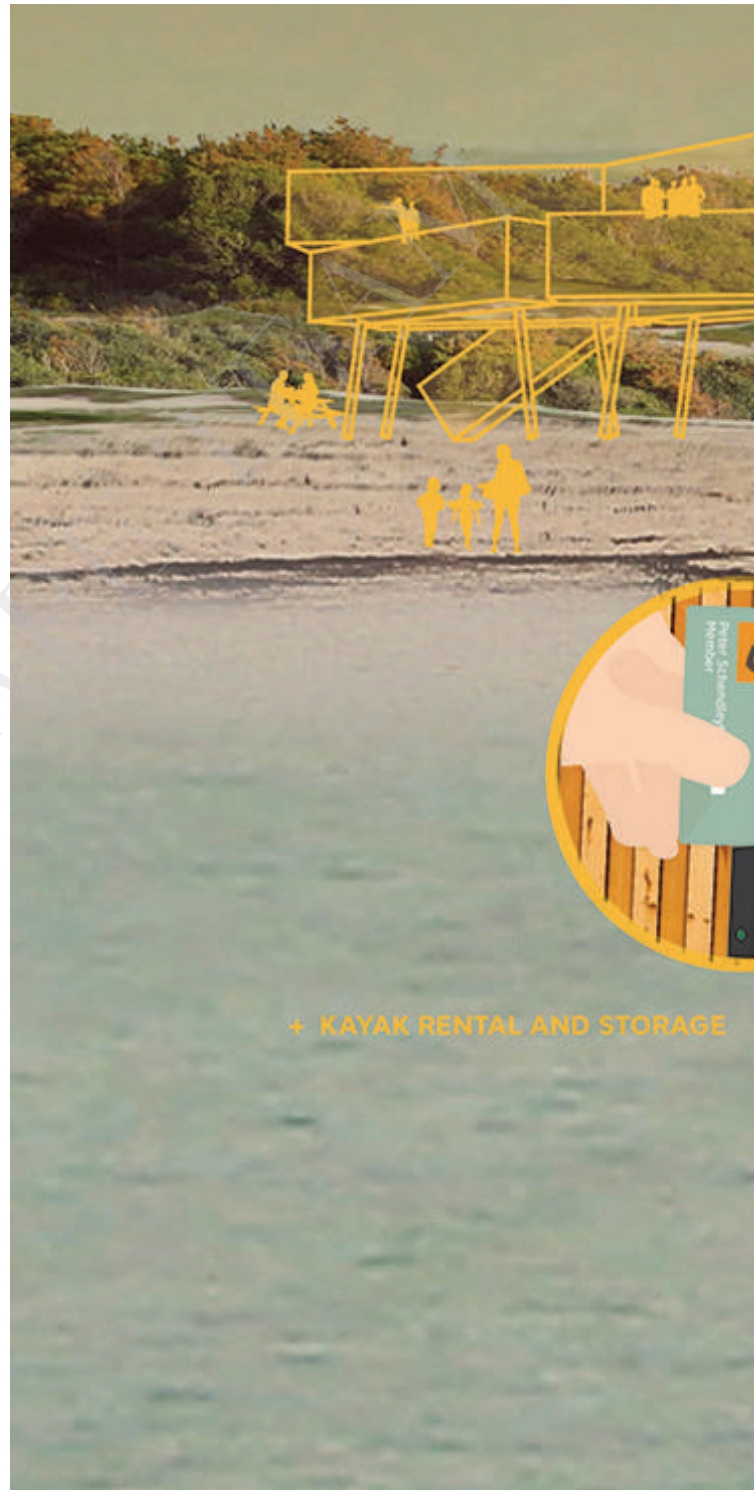


COMMUNITY WATER HUBS

Staten Islanders can reconnect to the coast through a network of highly visible and programmed Water Hubs, which provide places for access, orientation, information, storage, and gathering. The hubs are to be designed through community design charrettes, where programs and needs are identified and incorporated into the structures. Each site condition and community need creates a different type of hub: embedded, floating, cantilevered or elevated.



Floating Water Hubs work as platforms for observation of the Living Breakwaters also function as fishing stations and offer spaces for educational workshops and field trips for oyster gardening by local schools. On-land Water Hubs rise above the base flood elevation without losing contact with the ground floor and embracing the co-existence with water. The lower structure contains the circulation and safe spaces with floodable program, integrated with the dune system creating a second layer of protection from wave action and flooding. The second level, designed as an open plan, is a flexible space for the main program such as ADA accessible classrooms, gathering spaces and services, and the third level for commercial and recreational program with access to bird watching stations. Designed and built with prefabricated modular systems, sustainable materials, and energy efficient equipment, the Water Hubs are replicable models with iconic presence.







“ Being able to show our students that these ecological systems are a way of protecting ourselves is absolutely tremendous.

- S.I. Teacher

”

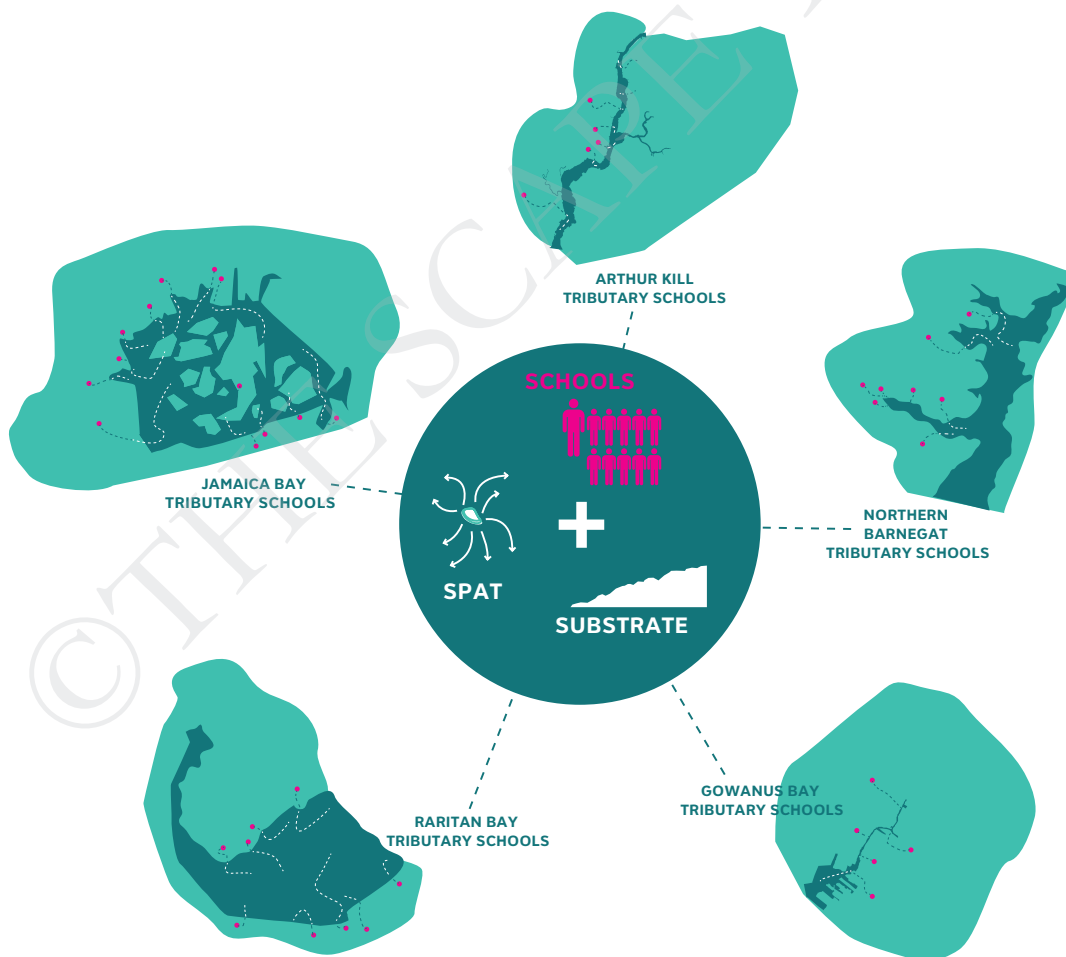


BUILDING COMMUNITY AROUND WATER

The project aims to engage Staten Island schools in waterfront education, restoration, and reef building. Local schools close to the waterfront can use the Water Hub gathering spaces for outdoor classes, hands-on education, and interactive maritime stewardship.

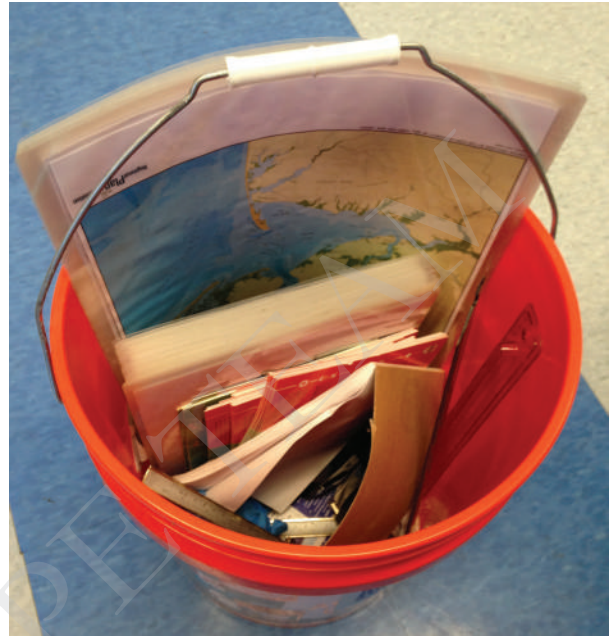
Schools offer additional opportunities for cultivating long term estuary stewardship. Our partner, The New York Harbor School, has advanced models for engaging middle and high school students in the

active restoration and management of the New York Harbor, from biological inventory to maritime job training. All strategies offer opportunities to engage local schools in building resiliency within a community. We will work with The Harbor School to integrate scalable activities into the local curriculum - from oyster gardening to reef building, that build maritime knowledge and preparedness at the neighborhood scale.



HARBOR AS A CLASSROOM

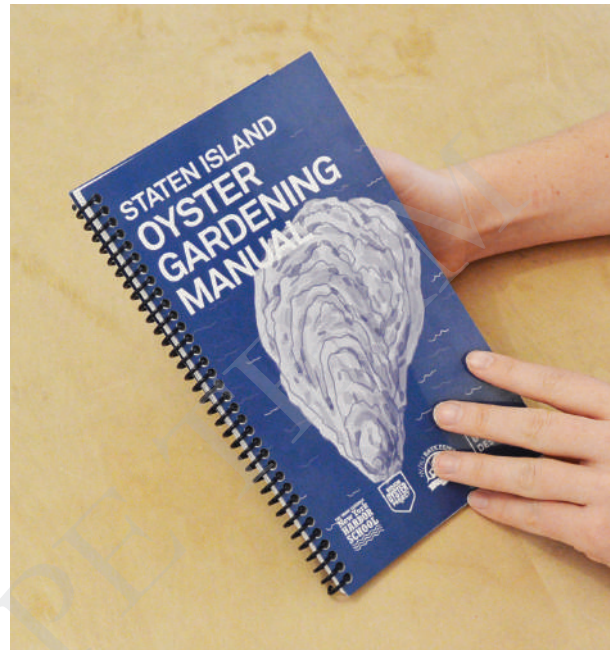
Living Breakwaters will engage Staten Island schools in waterfront education, restoration, and reef restoration. Local schools can use the Water Hubs for outdoor classes, hands-on science based education, and maritime skill building. The Billion Oyster Project (BOP) is a long-term initiative linked to this proposal to restore one billion live oysters to New York Harbor over the next twenty years and in the process, train thousands of young people to restore the ecology and economy of their local marine environment.



THE OYSTER GARDENING MANUAL

M

As advanced through Rebuild by Design, together we created the BOP Staten Island Oyster Gardening Manual and held public workshops where teachers signed up to become BOP schools. Individual classrooms can reconnect with the waterfront using oyster gardening techniques and referencing the BOP manual and associated curriculum guide. This strategy is one of many opportunities to bring our schools and the next generation of Staten Islanders into the design, management, and stewardship of bay ecosystems.



“The Billion Oyster Project is vital to integrating the kids of Staten Island to their ‘islandness.’
- S.I. Teacher”

We're growing oysters in my school!

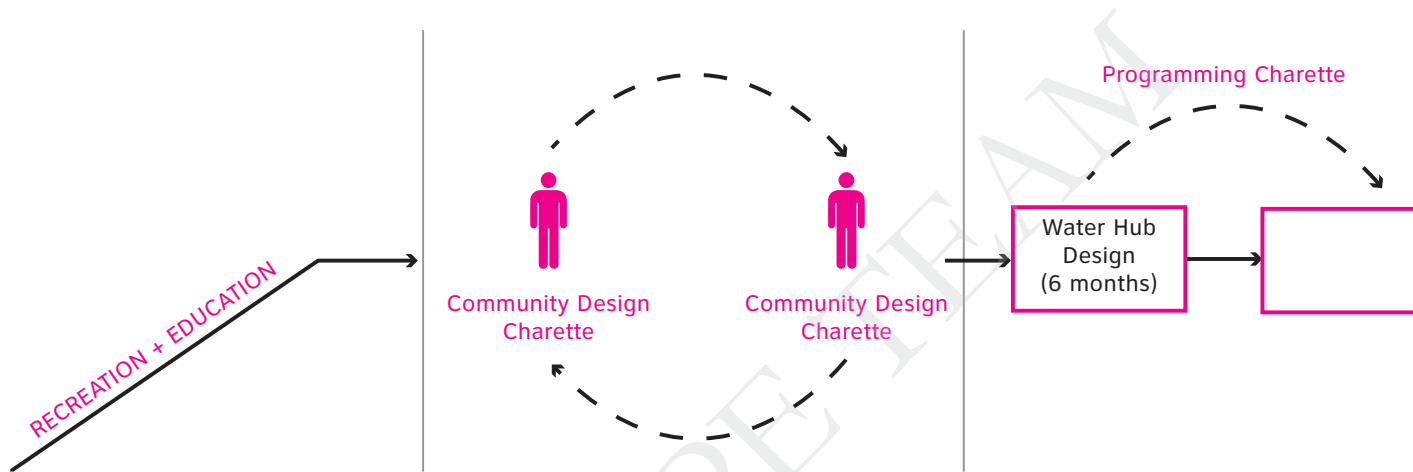
I remember, 10 years ago, it was way easier to harvest these oysters.

Back in the day, there used to be so many oysters...

I wonder what happened to the oysters that used to be here?



COMMUNITY LED DESIGN PROCESS



Community input is critical to the design process. At this stage of the design process, we have met with community members and stakeholders to collectively brainstorm on how to best program and occupy the Water Hubs. Input from Kayak Staten Island, the New York Rising Committee, and Conference House Park was especially useful for the Tottenville Water Hub concept. Moving forward, these constituents and the broader community will continue to shape the design process. While part of a larger resilient shoreline, the Water Hubs can be advanced as a more immediate step of Rebuild by Design, showcasing positive change on the shoreline in a measureable and quick way.





Is it possible to complete this project faster?

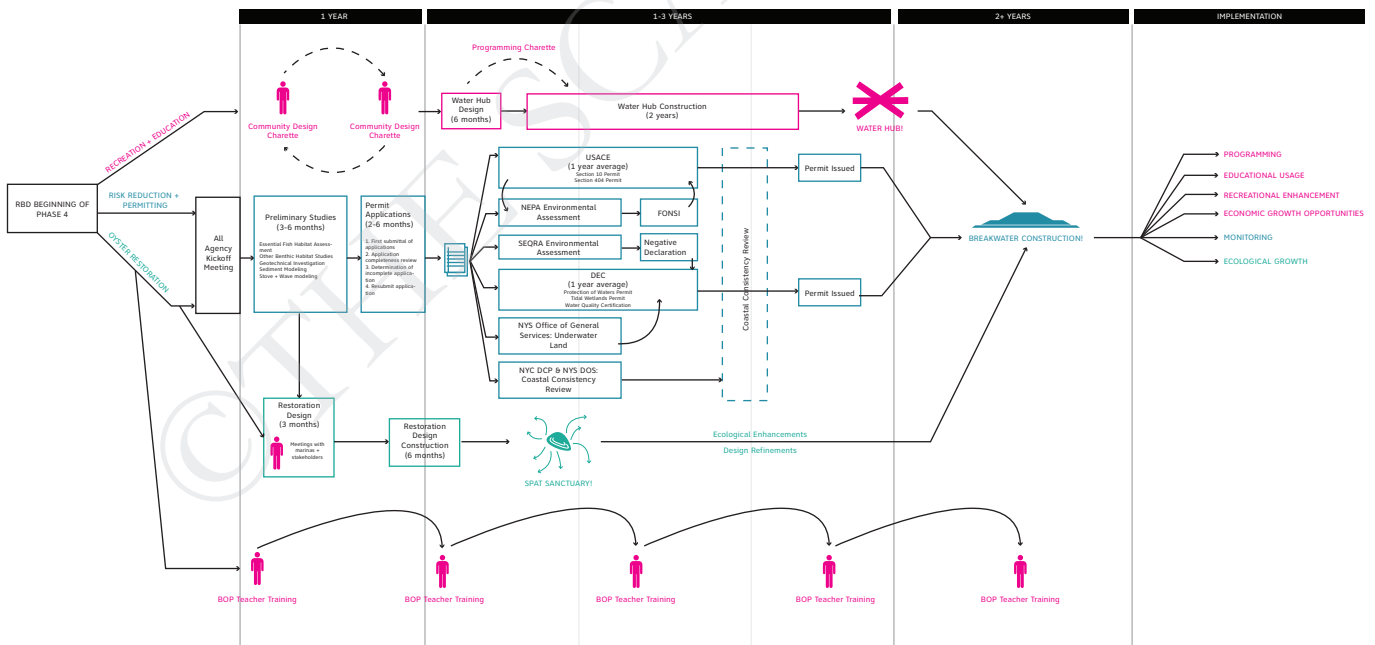
- S.I. Resident

Water Hub Construction
(2 years)



WATER HUB!

BREAKWATER CONSTRUCTION!



WATER HUB PROGRAMMING

BIRDWATCH

SOLAR ENERGY

OBSERVATION DECK

BATHROOMS

CLASSROOM

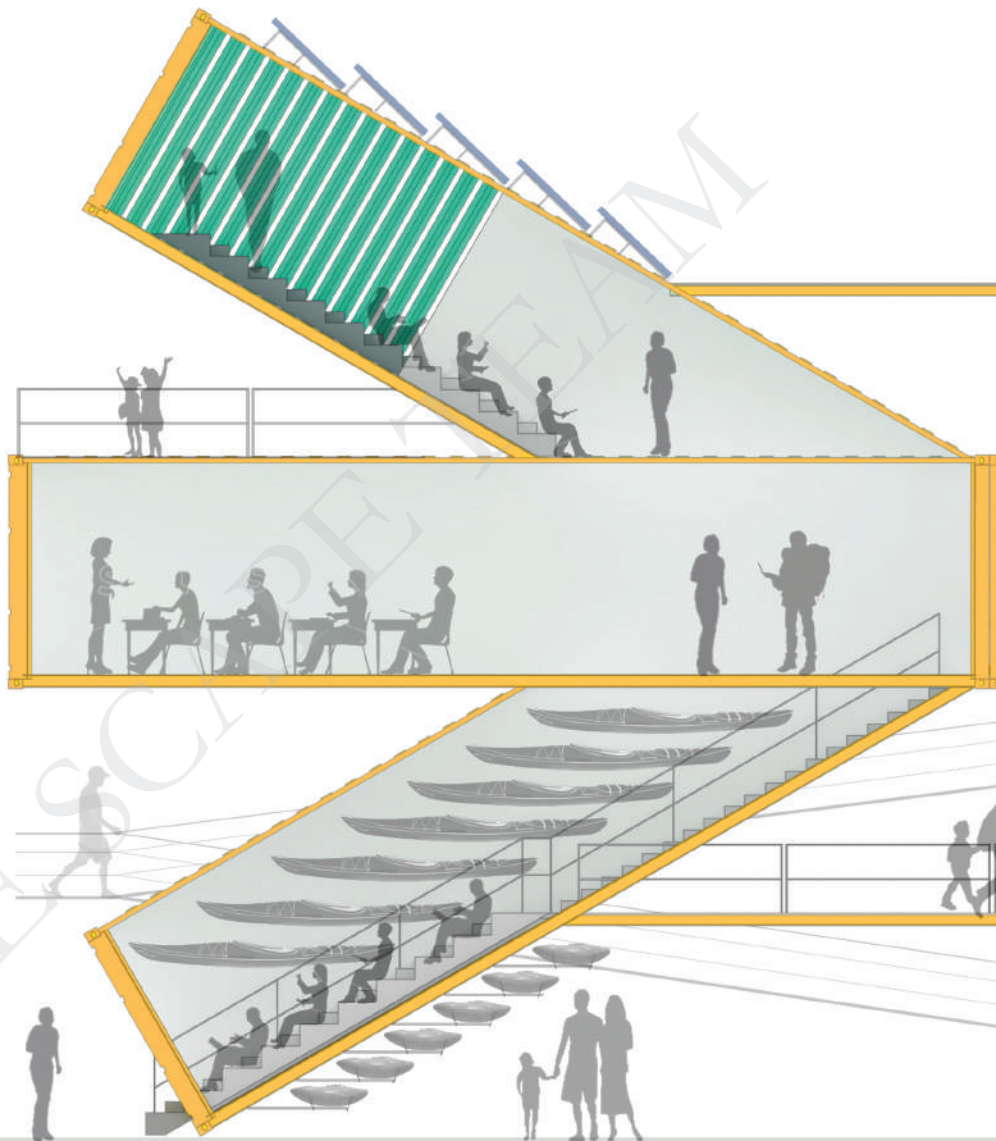
WET LAB

OYSTER GARDENING

ADA ACCESS

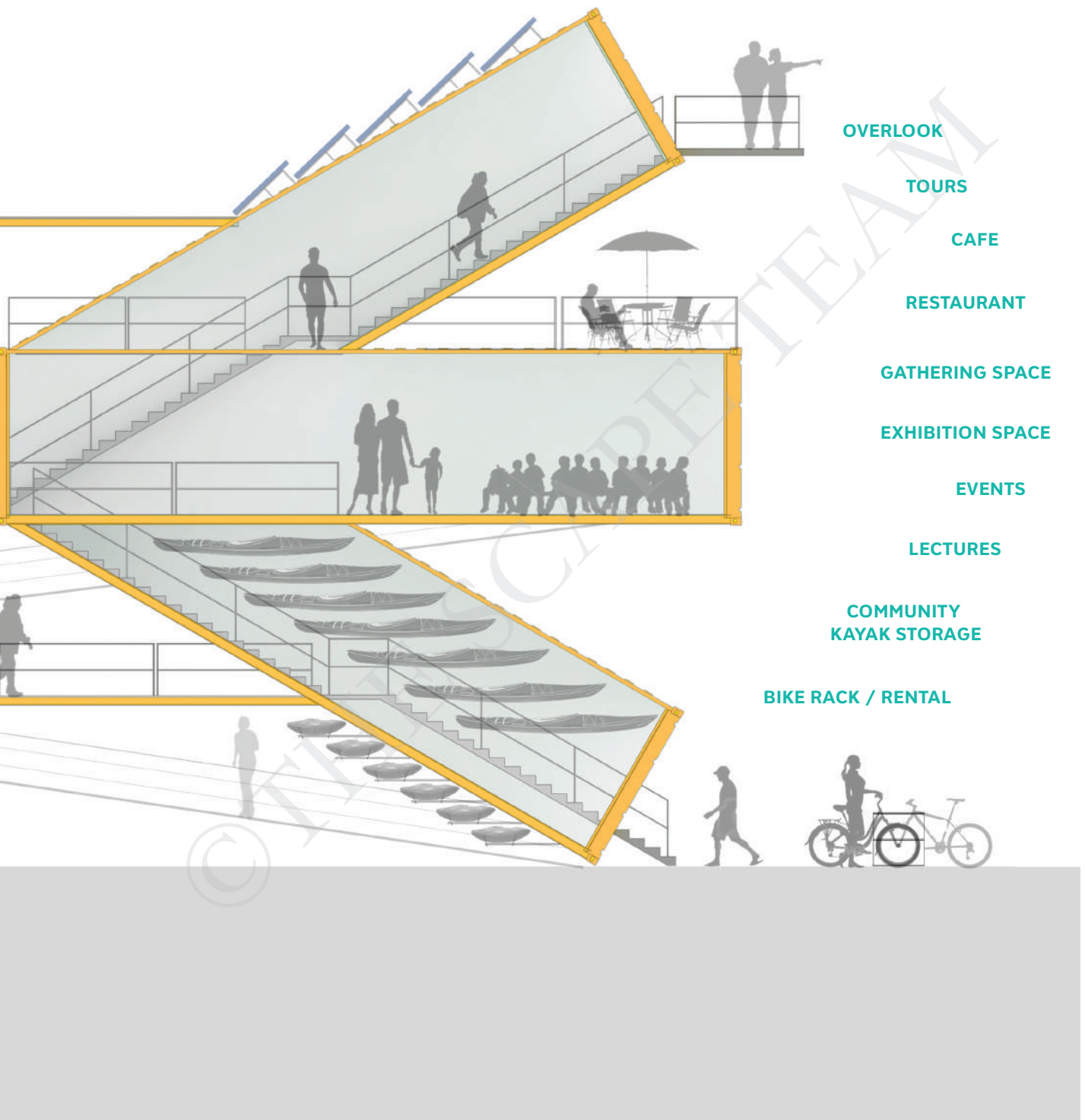
KAYAK LOUNGE

OUTDOOR CLASSROOM



The programming for each Water Hub is shaped by its particular location, context, and the community needs and aspirations. At its core, the purpose of the Water Hub is to connect people to the water, encourage water-based activities, provide infrastructure for recreation and education, and create a platform for the community to meet and learn. Besides of offering

basic services such as bathrooms and water fountains, the Water Hubs include a kayak lounge, community kayak storage, classrooms for local schools, wet-lab for The Harbor School, flexible space for community workshops, gatherings and exhibitions, local restaurant, bird watching stations and nature observation decks.

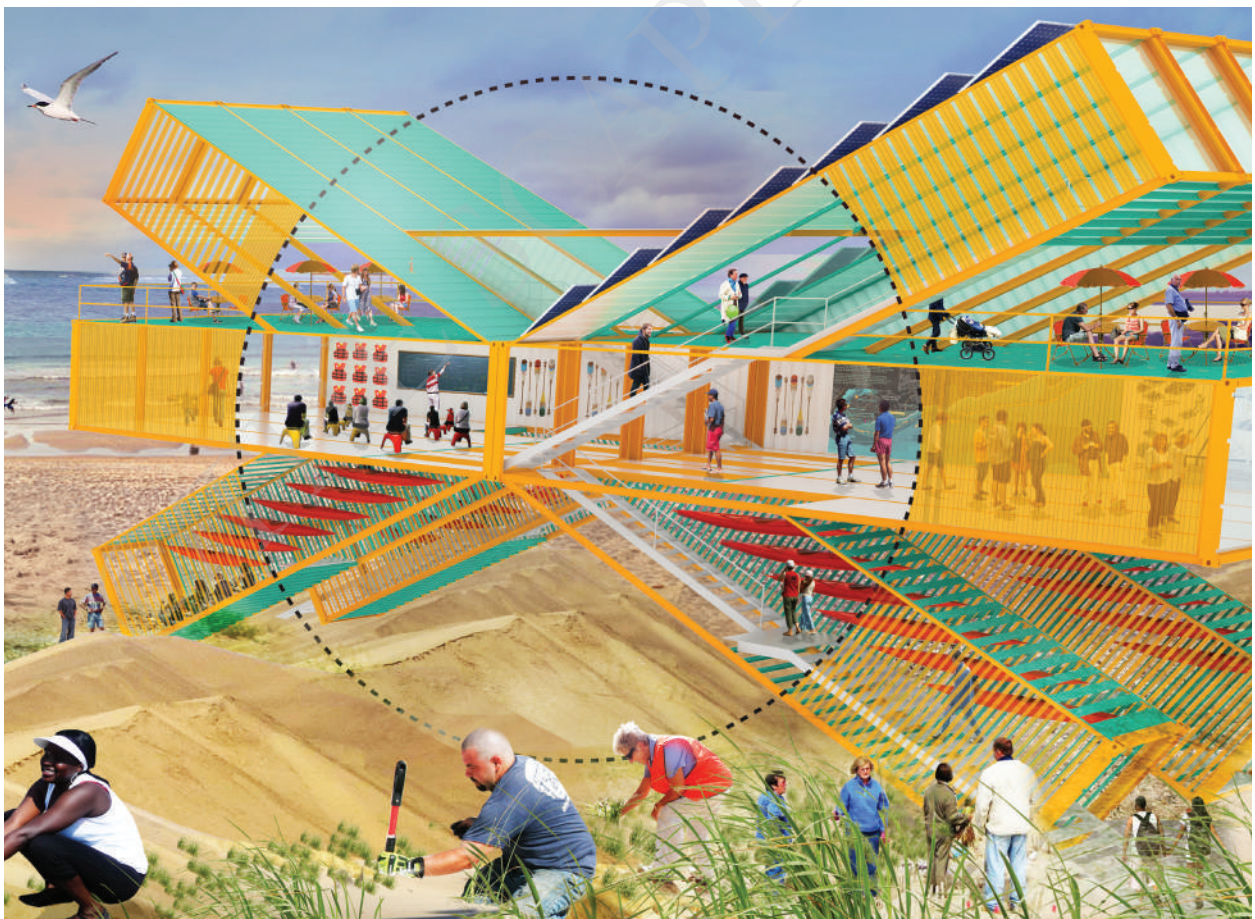


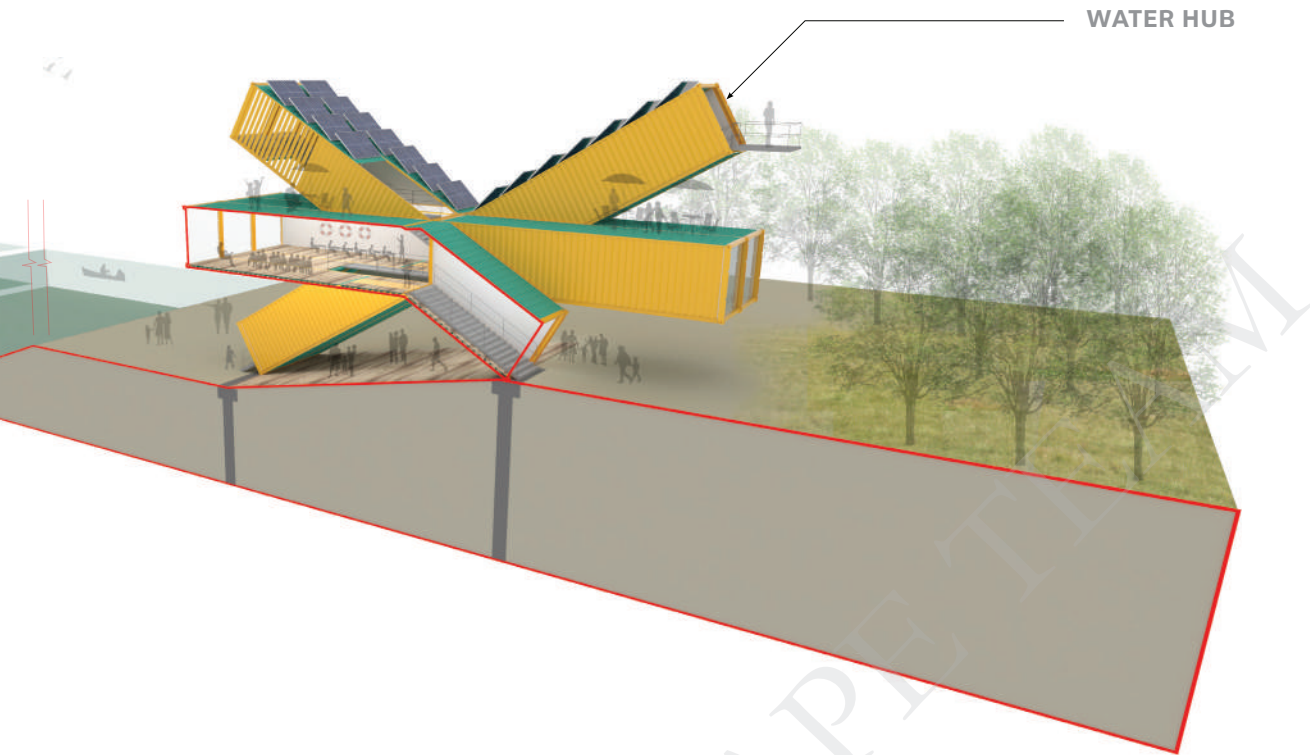
TOTTENVILLE WATER HUB

The end of Page Avenue at Tottenville Conference House Park was identified as a pilot site for Water Hub construction, due to its proximity to a residential district, PS 6 Corporal Allan F. Kivlehan School and public transportation. Community members identified program for the Tottenville Water Hub, including a kayak Lounge, kayak storage facility, public services, classroom space and wet lab for local schools, flexible space for exhibitions, workshops and community gathering, plus restaurant and birdwatching deck and birdblind tower at the top level.

LIVING
BREAKWATERS

DISTANCE
VARIES





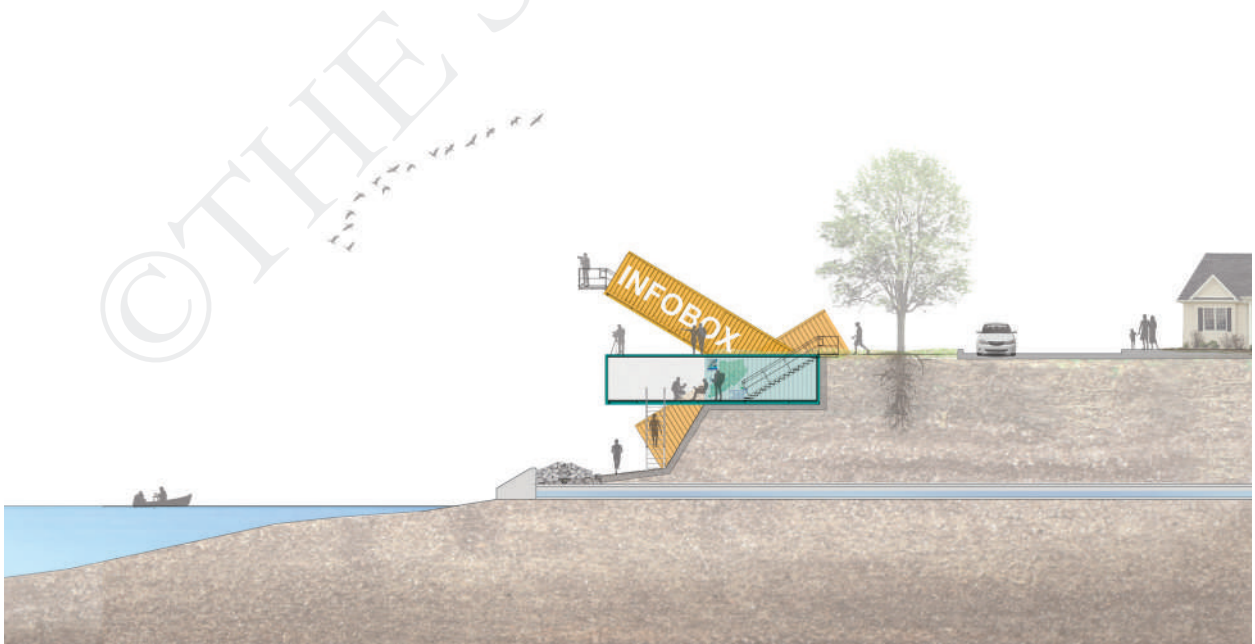
LEMON CREEK WATER HUB

Located at Prince's bay shore, mediating between Brighton street residential development and Lemon Creek's marina, the Lemon Creek Water Hub performs at multiple levels. From the ground up, the structure's base is intended to act as a retention wall for the highly erosion prone condition of the site while framing the Bluebelt culvert running underneath.

The building is meant to bridge the street level with the beach level, allowing direct access to the water. Given the active Birdwatching culture at the site, Lemon Creek's Water Hub offers viewing decks and a birdblind tower for local residents and aficionados plus a visitor's center for tourists alike.



“
These breakwaters not only create habitat diversity - they build entire ecological communities.
”
-NOAA employee

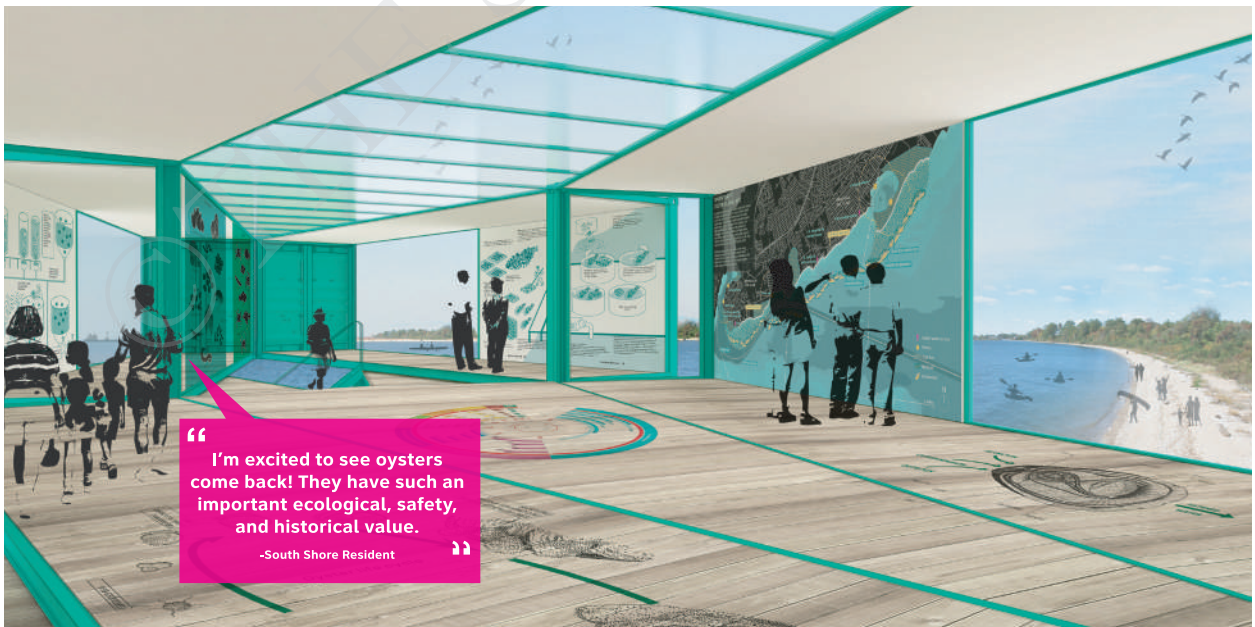
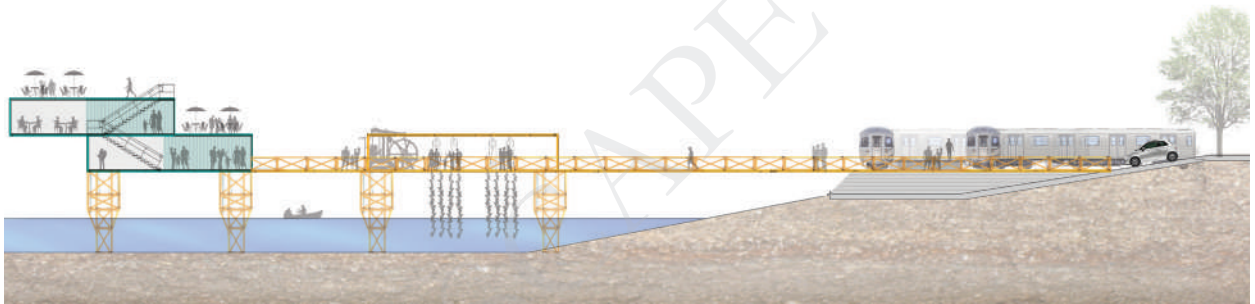


MILL CREEK/TOTTENVILLE STATION WATER HUB

Located in the southernmost point of New York State, Tottenville Station is the southern terminus of the main rail line. Taking advantage of the direct public transportation access, for this site we envision a bifurcated pier structure that extends over the Arthur Kill Channel, resembling the Bentley Street Ferry Terminal that used to operate on this location until the mid 1900's. A pier structure integrates sheltered areas, and a "head house" for commercial activity such as an Oyster bar, educational space for Oyster gardening, and a cultural space for potential showcases and events by the Tottenville Historical Society.



VIEW OF THE HISTORIC TOTTENVILLE
FERRY TERMINAL, 1898

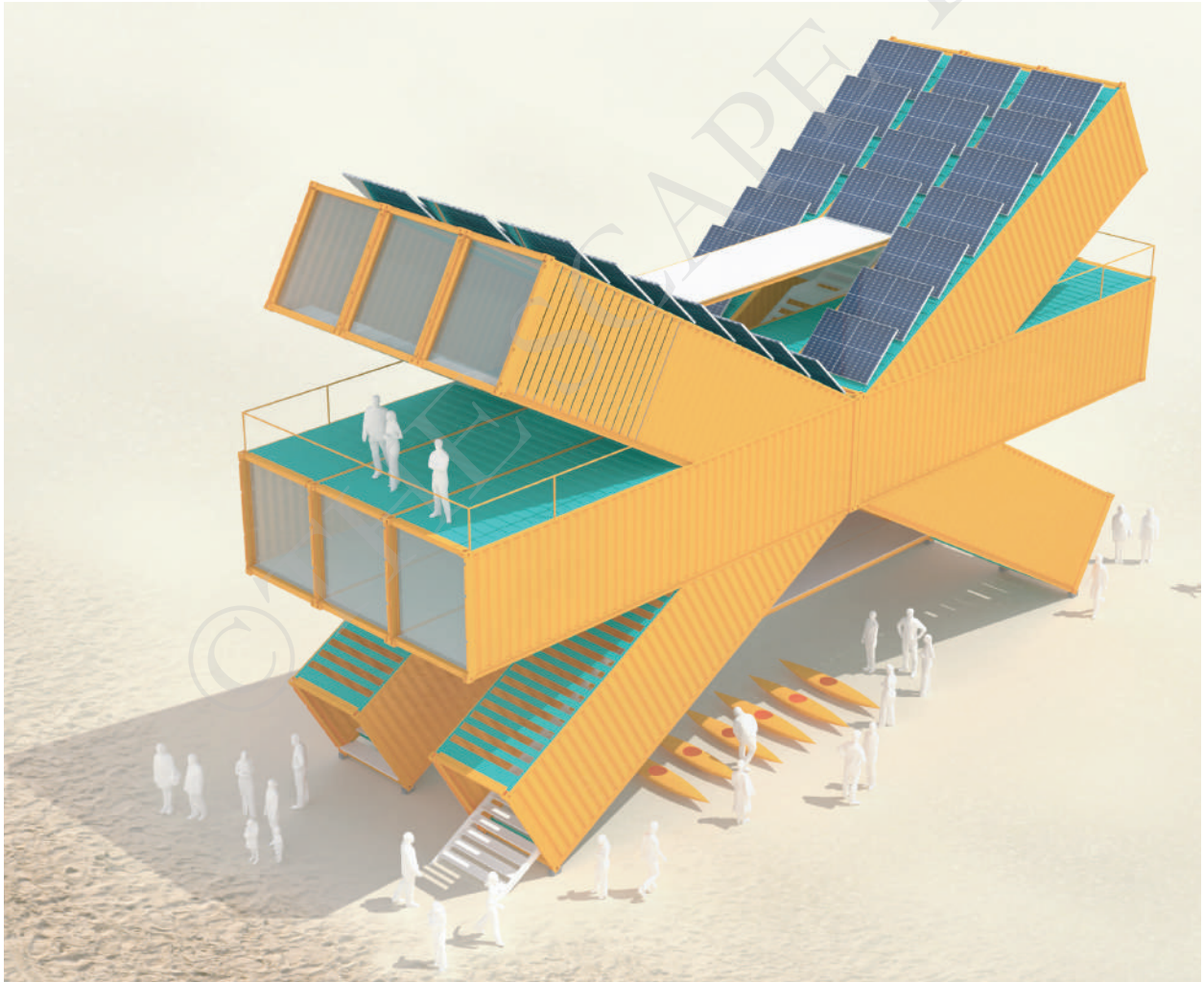


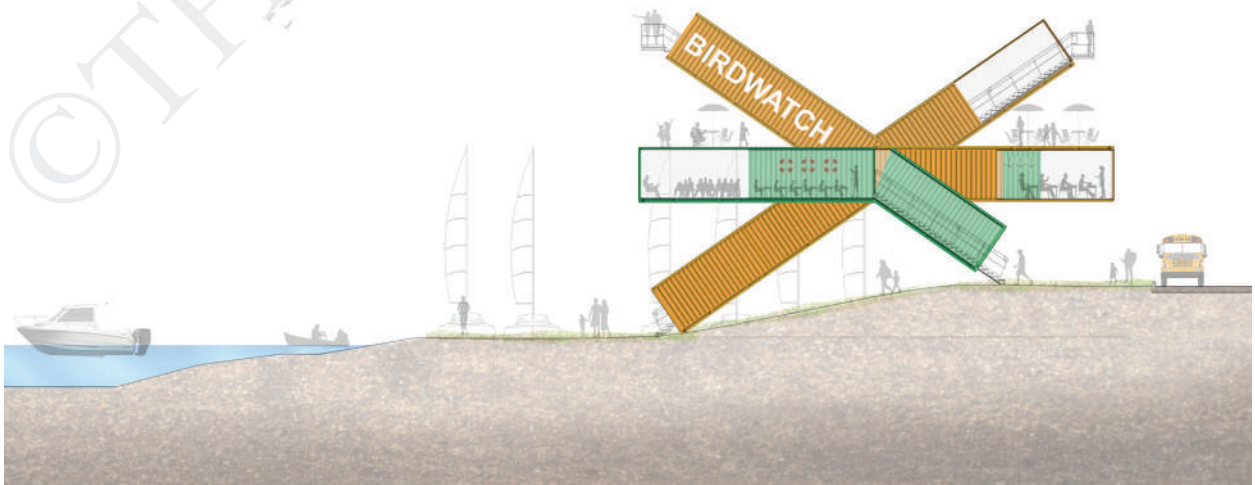
“I’m excited to see oysters come back! They have such an important ecological, safety, and historical value.”

-South Shore Resident

CRESCENT BEACH WATER HUB

Located at Crescent Beach, an area that was highly flooded and damaged during Superstorm Sandy, the Water Hub rises above the Base flood elevation, containing floodable program below the Design flood elevation such as kayak launch and kayak storage. The hub, conveniently located on NYC Parks and Recreation property, has a close proximity to many of the local schools, offering them space for education and summer activities as well as for boating training.





PARTNERING & IMPLEMENTATION

COMMUNITY & AGENCY INPUT
COALITION BUILDING
A ROBUST REGULATORY STRATEGY
STRONG FUNDING JUSTIFICATION

***THE SEPARATE DOCUMENT “TECHNICAL APPENDIX”
INCLUDES DETAILED DOCUMENTATION OF THE FOLLOWING:**

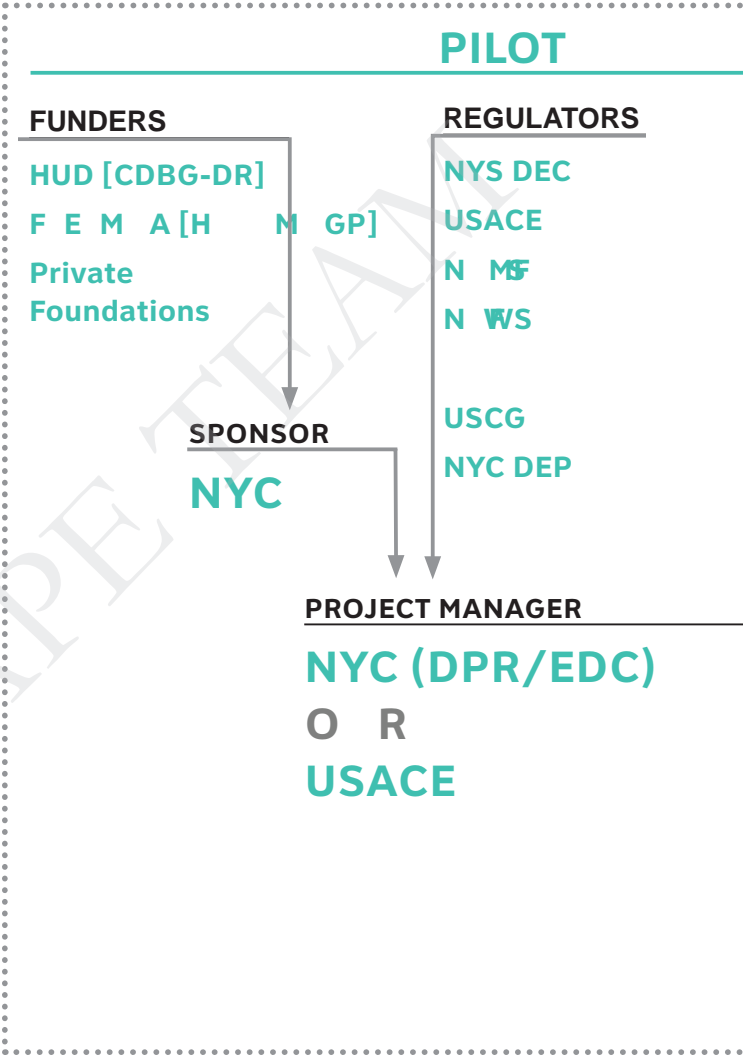
LETTERS OF SUPPORT
COST BENEFIT ANALYSIS
PILOT REGULATORY PATHWAY
MODEL RESULTS
FINANCING PLAN
MONITORING

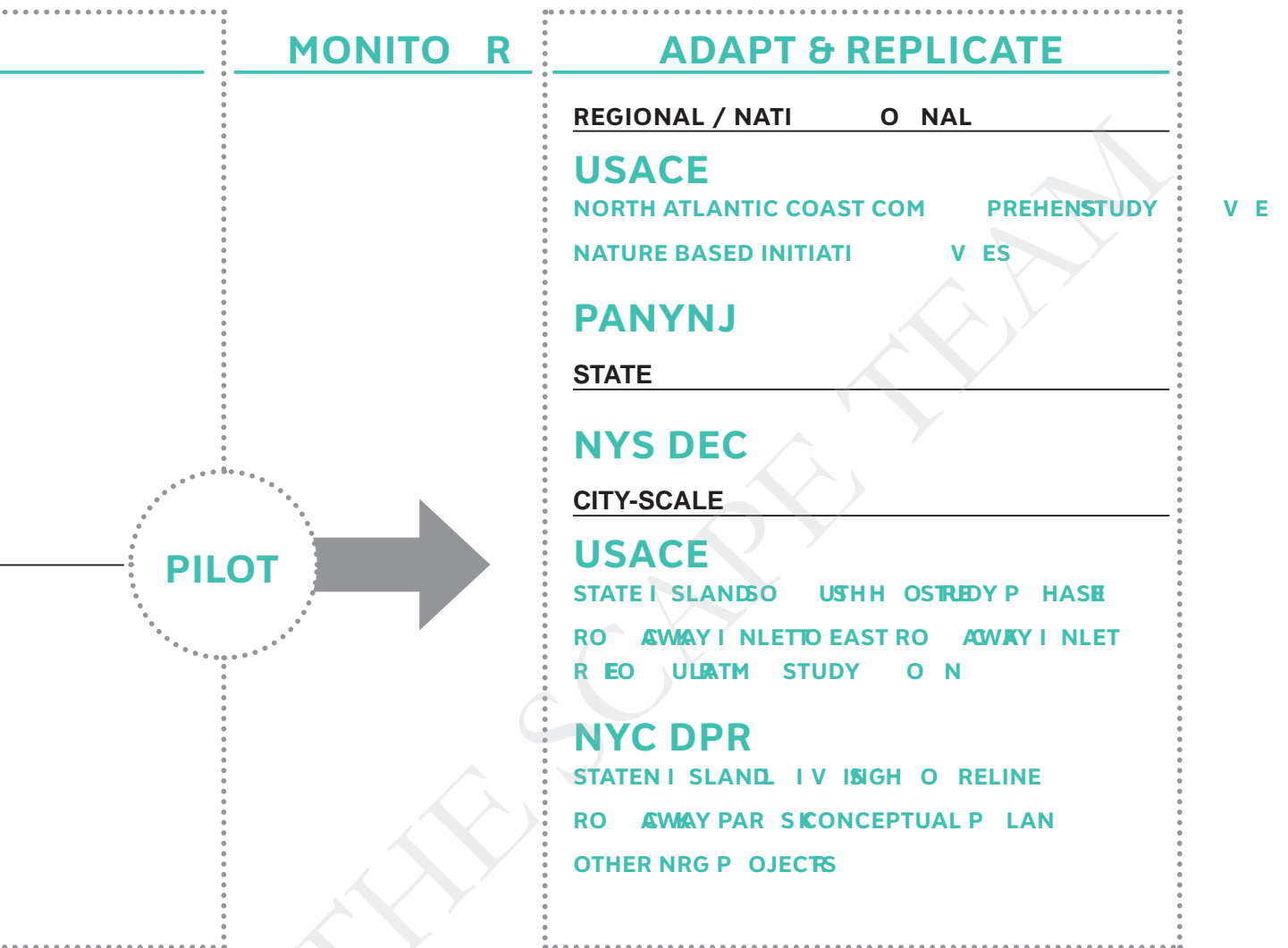
IMPLEMENTATION

Implementation of the project will happen in two key phases: (A) implementing a large-scale Living Breakwater pilot project at Tottenville, (B) expanding the living breakwater strategy to the remainder of the Staten Island South Shore, and other appropriate locations in the region and even nationally.

While we believe that the justification and need for this project is clear through the benefits that it brings in the form of **REDUCING RISK, ENHANCING ECOLOGICAL RESILIENCY** and **BUILDING SOCIAL RESILIENCY**, we understand that in order to realize its benefits this project needs to be implementable. Implementation will require a strategy that addresses not only the constructability of the project, but the permitability and fundability of Living Breakwaters in the physical, political, and regulatory context of New York Harbor. Successful implementation will require four key elements:

- (1) COMMUNITY AND AGENCY INPUT
- (2) COALITION BUILDING
- (3) A ROBUST REGULATORY STRATEGY
- (4) STRONG UNDERSTANDING OF





COMMUNITY & AGENCY INPUT TIMELINE

NOV 2013

Our team benefitted from diverse input from a range of stakeholders. A series of community meetings in Mt. Loretto crafted our approach and helped us determine the physical extents of our proposed pilot. Regular meetings with regulators and habitat specialists at The Army Corps, NYS DEC, US WFS, Marine Fisheries, and others helped to craft our approach to the design. In addition, we met with Clammers in Staten Island to map clam beds and held an “Oyster Summit” of restoration experts to develop a range of techniques that would help advance restoration science, monitoring, and maintenance practices within the scope of our pilot project. We conducted several teacher outreach workshops and heard first hand from secondary and high school science teachers about the need for and great interest in this project and the range of programming strategies and facilities embedded.



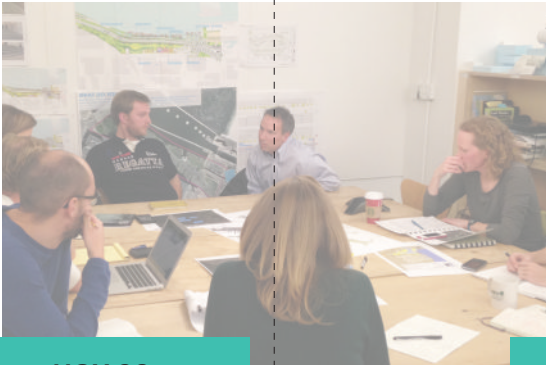
**NOV 12
GUIDED
SHORELINE
BOAT TOUR
STATEN ISLAND/
RARITAN BAY**

“The next step is to conduct studies to determine environmental impact outside the breakwater footprint.”
- DEC employee

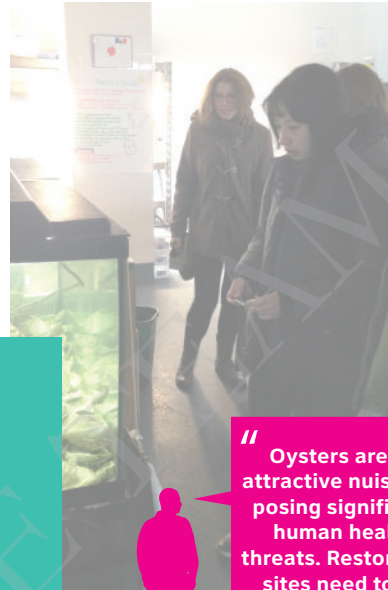
**DEC 19
NYC
AGENCIES
MEETING**



DEC



**NOV 26
BAYKEEPERS
+
HUDSON RIVER
FOUNDATION
MEETING**



**DEC 13
HARBOR
SCHOOL
VISIT
GOVERNORS
ISLAND**

“ Oysters are an attractive nuisance, posing significant human health threats. Restoration sites need to be carefully monitored.

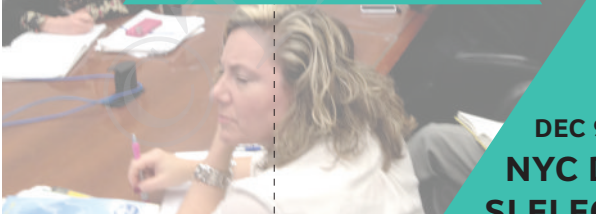
- DEC Employee



**DEC 4
USACE
MEETING**



**DEC 20
DEC/TNC
MEETINGS**



**DEC 9-13
NYC DPR/
SI ELECTEDS
NPS/ MEETINGS**

“ A continuum of protection is absolutely essential along the South Shore.

- Parks employee



JAN 2014

FEB



**JAN 23
NY RISING
STATEN ISLAND
COMITTEE MTG
JCC
STATEN ISLAND**



**FEB 4
STATEN
ISLAND
COMMUNITY
MTG #1
MT LORETTO**

This project could be the catalyst for other planning processes around the island.

- NY Rising committee member

**JAN 13
PS 57 SCHOOL
OUTREACH
MEETING**

**JAN 16
TOTTENVILLE
CIVIC ASS.
+ FISHERMENS
CONSERVATION
ASS. MTGS**



**JAN 14-16
DEC/
NYC OLTPS/
SI BOROUGH
PRESIDENT MTGS**

**JAN 28-31
USACE
EDC/DOS CC/
NOAA MEETINGS**



**FEB 26
TEACHER
OUTREACH
WORKSHOP
NEW DORP
HIGH SCHOOL**



**JAN 23-24
DEC/
NYC DPR/SI
CLAMMERS/NY
RISING MEETINGS**



**FEB 20
OLTPS
MEETING
NYC**

M AR

APR



**MAR 11
STATEN
ISLAND
COMMUNITY
MTG #2
MT LORETTO**



**MAR 23
SCALE IT UP!
STATEN ISLAND
MUSEUM**

**MAR 4
COAST GUARD
MEETING**

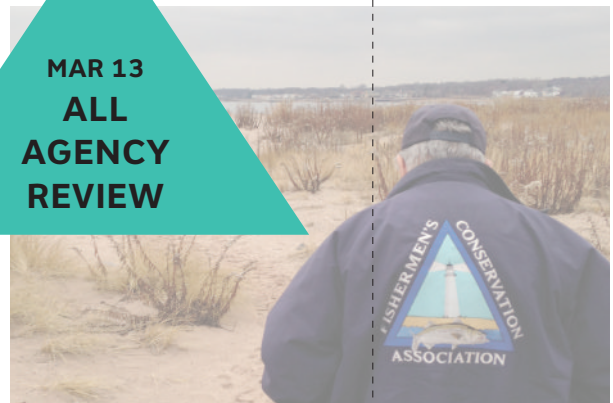


**MAR 15
REEF
BUILDING
WORKSHOP
STATEN ISLAND
MAKER SPACE**



**APR 3
STAGE III
PUBLIC
PRESENTATION
JERSEY CITY &
MANHATTAN**

**MAR 13
ALL
AGENCY
REVIEW**



**MAR 13
DEC
FINAL
REVIEW**

Keep going!
- DEC employee

COALITION BUILDING

The Rebuild by Design competition itself illustrates the level of commitment at the federal level and specifically by the Department of Housing and Urban Development (HUD) to the development and implementation of innovative solutions such as Living Breakwaters. Support from HUD and the competition's project partners have helped spur commitment to this design. Support for Living Breakwaters goes well beyond the competition as national, state, and local leaders have voiced their support for this project, not to mention the many individuals and local, city, and harbor-wide organizations whose support is illustrated through the many letters of support submitted for this project. In New York City, resiliency is also high on the City's agenda - The Special Initiative for Rebuilding and Resiliency lays out the City's agenda regarding resiliency and specifically identifies breakwaters for the South Shore of Staten Island.

It would make science class even more fun. I already want to go there!

- S.I. Eighth Grader

From left to right: Staten Island Borough President James Oddo (R), New York State Senator Andrew Lanza (R), U.S. Senator Charles Schumer (D), New York State Assemblyman Joseph Borelli (R), New York City Councilmember Vincent Ignizio (R), New York City First Deputy Commissioner of Parks & Recreation Liam Kavanagh



LETTERS OF SUPPORT

Mura S. Barnes Intermediate School #24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014
F

Dear Secretary Donovan,
My name is Danielle Kezel. ~~Am~~ Ms. Amoroso, our science teacher, informed us about a project for the Staten Island beaches. I think this plan is an excellent idea because now I never really do go to the beach because it's not really interesting or fun there. And the water looks really disgusting. However, having a lab by the beach would be AMAZING! Plus, it would make science class even more fun. Anyway, I really hope they build that soon. I already want to go there.

Sincerely,
Danielle Kezel

UNITED STATES SENATE
OFFICE OF SENATOR ANDREW J. LANZA
WASHINGTON, DC 20540

March 20, 2014

Dear Secretary Donovan,
I am writing in support of SCAPE's Living Breakwater, a Rebuild by Design initiative that will help protect Staten Island from future storms, enhance ecology, and connect residents and students to our shoreline.

The people of Staten Island suffered devastating and tragic losses as a result of Hurricane Sandy. For the south shore, especially the Tottenville area the storm hit hardest and left us with a lot of damage. Despite the efforts of the City and the State to stem this erosion, the shoreline continues to erode, leaving homes, parkland, and businesses exposed to future storms. Some 84 families were directly impacted with major losses due to the storm surge from Super Storm Sandy.

One of the teams selected to participate in your Rebuild by Design program has identified an innovative and important means of stemming these losses. The proposal by SCAPE and their partners for a living breakwater would reduce the destructive force of waves, preventing erosion of the beaches and bluffs that protect the community from storms. These reef-like structures are specially designed to enhance coastal ecology, important for both the fish and the commercial and recreational businesses that depend on healthy fisheries for their livelihood. The SCAPE team has also made the community a critical element in the program, in particular by proposing a way to reconnect the shoreline's connection to Staten Island's rich maritime heritage and in particular the lives of secondary school students.

Thank you for your consideration of the SCAPE's Living Breakwater proposal and please feel free to reach out to my office if you have any questions about our engagement in this process.

Sincerely,
Andrew J. Lanza
United States Senate

Tottenville Civic Association, Inc.

Shawn Donovan
Secretary
United States Department of Housing and Urban Development
451 Seventh Street, S.W.
Washington, DC 20410

Dear Secretary Donovan,

This letter is in support of SCAPE's Living Breakwater, a Rebuild by Design initiative that will help protect the South Shore of Staten Island from future storms, enhance ecology, and connect residents and students to our shoreline. Currently our only protection is from temporary dunes, which will leave us vulnerable to future storms. As a Tottenville civic meeting held March 19/2014 attended by over 100 Tottenville residents representing a cross section of our community and attended by the Borough President and all South Shore City and State Representatives, unanimous support was given to this project. The Conference House Park Conservancy Inc. also endorsed this project.

The people of Staten Island suffered devastating and tragic losses as a result of Hurricane Sandy. For the south shore, especially the Tottenville area the storm hit hardest and left us with a lot of damage. Despite the efforts of the City and the State to stem this erosion, the shoreline continues to erode, leaving homes, parkland, and businesses exposed to future storms. Some 84 families were directly impacted with major losses due to the storm surge from Super Storm Sandy.

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Thank you for your leadership of the President's Task Force and on continuing to push for innovative ways of managing Sandy recovery and rebuilding with community results. The SCAPE project has deferred on that goal. We urge you to find the means to continue to advance this important proposal.

Sincerely,
James M. Pistilli
President, Tottenville Civic Association, Inc.

3414 Arthur Kill Road, Staten Island, NY 10310 E-mail: james@tcaonline.com

UNITED STATES SENATE
OFFICE OF SENATOR ANDREW J. LANZA
WASHINGTON, DC 20540

March 20, 2014

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The people of Staten Island suffered devastating and tragic losses as a result of Hurricane Sandy. For the south shore, the storm hit hardest and left us with a lot of damage. Despite the efforts of the City and the State to stem this erosion, the shoreline continues to erode, leaving homes, parkland, and businesses exposed to future storms.

The SCAPE team has identified an innovative and important means of stemming these losses. The proposal by SCAPE and their partners for a living breakwater would reduce the destructive force of waves, preventing erosion of the beaches and bluffs that protect the community from storms. These reef-like structures are specially designed to enhance coastal ecology, important for both the fish and the commercial and recreational businesses that depend on healthy fisheries for their livelihood. The SCAPE team has also made the community a critical element in the program, in particular by proposing a way to reconnect the shoreline's connection to Staten Island's rich maritime heritage and in particular the lives of secondary school students.

Thank you for your consideration of the SCAPE's Living Breakwater proposal and please feel free to reach out to my office if you have any questions about our engagement in this process.

Sincerely,
Charles E. Schumer
United States Senate

James S. Oddo, President of the Borough of Staten Island, City of New York

Vincent M. Ignizio, Minority Leader, The Council of New York City Hall

Andrew J. Lanza, New York State Senate, 24th District

Charles E. Schumer, United States Senate, New York

Rev. Terry Troia, President, Staten Island Longterm Recovery Organization

Meredith Comi, Oyster Restoration Project Director, NY/NJ Baykeeper

James M. Pistilli, Tottenville Civic Association

Community Board 3, NYC

NY Rising Community Reconstruction Program, Staten Island Planning Committee

Debra A. Amoroso, Myra S. Barnes Intermediate School 24

Samantha Shakhvorostova, Salvatore Bonamassa, Carmela, Danielle Kezel, Izabela Rak, Maria, Madison Matteo, Luke Peteley, Bernadette Mustacchio, Ryan Gough, Jonathan Colella, Gianna M., Isaak Dorvin, Jillian O'Brien, Shane DeSilva, Kelly Nickel, Gerta Cako, Samantha Sette, Michelle Grishchenko; students of Intermediate School 24 in Staten Island

Brett F. Branco, Ph.D. Department of Earth and Environmental Sciences, Brooklyn College, The City University of New York

Katrina Johnstone, Co-founder, Kayak Staten Island

Alan I. Benimoff, Ph.D., College of Staten Island

SELECTION OF LETTERS

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014

Dear Secretary Donovan:

As a student of the 9th grade, I'm heading off to high school. My favorite subject and the field I want my career in to be in the future, is science. Science is my passion and I enjoy learning as much as I can^{about it}. Having this project in Staten Island would mean a lot to me and all the residents. This plan would bring everyone closer to nature and let them learn more about it. This would inspire people like me to take interest. Bringing people closer to nature will hopefully make them care more for the environment. This project will show us the potential that our Island has. As for all the boroughs, we don't have many attractions and all those skyscrapers. We are surrounded by water, so why not use that to attract audiences to us and show why we are unique. We are often forgotten about and don't get much attention brought to us, even after hurricane Sandy. So many people were devastated; as for myself, I had no power for a week. Bringing this project here would give Staten Island something to attract people and make people more interested in us. I really hope to have this here because I have shores very close to where I live and I love being by the water. Having it would make me get out even more and enjoy the water so much more.

From,
Samantha Shakhvorostova 833

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014

Dear Secretary Donovan,

My name is Maria. I am 14 years old and attend I.S. 24 as an eighth grader. Staten Island can get a bit ~~very~~ boring sometimes. The only two things to do at Staten Island is its mall and the movie theaters. The beaches aren't like the one's in Long Island or any other borough. I would appreciate it, if you fund us to build hubs on the beaches, to make Staten Island a bit more fun. The other boroughs are all known for things such as Manhattan - its building, Brooklyn - the environment, Queens - the apartments, ~~the~~ and the Bronx - its zoo. We are known as the boring borough, but we wouldn't if we had nice beaches and various activities to do there. Even if we aren't recognized as the borough with nice beaches, at least my peers, classmates, and all the students will be able to go to the beach and learn about ~~marine~~ and marine biology and observe the water.

From,

Maria

Madison Matteo

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY, 10308
March 20, 2014

Dear Secretary Donovan:

My name is Madison Matteo. My classmates and I are 8th grade students at Myra S. Barnes Intermediate School. Our school is considerably close to Staten Island's waterfront, and our teacher has informed us about a plan to grow oysters and free them into the water. I think that this would be a great idea. The project would be an educational and memorable experience in our last year of I.S. 24, and it would also contribute well to the environment. Oysters are naturally filters, and would clean the water while preventing something as devastating as Super-Storm Sandy from happening again. Please take all of this into consideration. We would be very grateful if you could make this project happen.

Sincerely,

Madison Matteo

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014

Dear Secretary Donovan:

My name is Bernadette Mustacchio and I'm ~~an~~ 8th grade student at I.S. 24. Mrs. Amoroso, my science teacher, recently informed us about a project that would help the water front on Staten Island. They would build reefs that would protect us from another storm like Sandy and community hubs. Our island would benefit so much from this. Sandy, unfortunately, devastated families all across the island. Some people were left homeless. This would ~~help~~ prevent ~~the~~ another tragedy. We will also be growing oysters and set them free to clean our water. Staten Islanders would benefit greatly from this. We would actually be able to utilize our beach. We would also attract many tourists which would help our economy. There will be many labs and activities, as well, that ~~we~~ could provide as will educational school trips. I hope you consider this.

Sincerely,

Bernadette Mustachio.

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014

Dear Secretary Donovan:

I am a child, a friend, a ^{neighbor,} ~~neighbor~~ but most importantly I am part of a community. My name is Luke Peterley and it is true I may just be an eighth grader at I.S. 24 but I have an opinion revolving around the construction of the reefs and the community hub establishments. My neighborhood has been devastated, places of memories shattered, neighbors introduced to a dark man that is called death. Never throughout my young life have I seen such a catastrophic event since 9/11. My home, I consider one of the lucky ones this is due to the fact that even though I live in a one floor ranch and water had come up into our dwelling our home was at least in tact. Homes had been equipt in flames, or even flattened by the bulkier like waves. Innocent lives were taken and Staten Island was scared for eternity, or so I thought. As a community we rose to the challenge we rebuilt, we fought, we survived, we as a community became sandy strong. We are tough, we are rough, but best of all in proud to be called a Staten Islander. New York needed aid, America answered, food was donated, clothes donated, comfort distributed, lives changed. As they say what doesn't kill you makes you stronger. Not in order to prevent another devastation such as this we must be provided with funds to construct this grand project. Lives are on the line if another one comes, kids could become educated

from the labs, the reefs could prevent another storm, the
hubs could help the community come together.

That is why I am pleading you not as a leader
or a student but as a fellow New Yorker. Thank you for
reading this letter and taking your time to understand
my cause for creating this piece, thank you.

Sincerely, your fellow Islander,
Luke Petreley

Myra S Barnes Intermediate School 24
225 Cleveland Ave.
Staten Island, NY, 10308

March 20, 2014

Secretary Donovan,

I haven't lived on Staten Island for very long. My father is in the military, so I have only lived here for 2 years. However, in the short time I've been here, I have realized that Staten Island has very little in comparison to the rest of New York. You might not live here, but I have learned to call this place home, and I want my home to be better than it is now. A program was recently proposed that would provide benefits for our home. Education would be provided for the children of New York through the growing of oysters, and the reefs built would lessen the damages of another Sandy. I don't know ~~about~~ about you, but that sounds like a pretty good deal. Staten Island isn't the most flashy or the most populated borough, but it has gotten the short end of the stick for too long. I am a voice in a million, but my name is Isaac Davon, and I think you should support this project.

Support our Borough,

I seek Davon

Isaac Davon

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014

Dear Secretary Donovan,

As a resident of Staten Island and a kid in the local community I feel Staten Island has very little for anyone to do anything. There's very few places for kids and adults to hangout. I would be more than happy to be able to experience your project in my home town. It seems to feel like Staten Island is always the left out borough, we have nothing here and it would feel good knowing people might actually like Staten Island and get some tourist over here other than Manhattan all the time. Mr. Donovan please pick Staten Island as your project place. My name is Kelly Nickel and I go to Myra S. Barnes Intermediate School 24 and I would love to see Staten Island as a place people want to live and visit in.

Sincerely,
Kelly Nickel

Myra S. Barnes Intermediate School 24
225 Cleveland Avenue
Staten Island, NY 10308

March 20, 2014

Dear Secretary Donovan:

My name is Samantha Settle and I'm an 8th grade student at Myra S. Barnes Intermediate School 24. My teacher recently informed my class about to build reefs in our water. Several days in the summer, my family and many others want to go out onto the beach. However, the water now is uncomfortably dirty. This plan would hopefully cleanse our waters and provide our borough with enjoyable beaches. Along with this, my family and several others were severely affected by Hurricane Sandy. In the event of a similar occurrence in the future, any possibility of lessening the destruction would be a huge help to our community. Growing oysters would sincerely benefit our Island and community.

Sincerely,
Samantha Settle



March 24, 2014

Shaun Donovan, Secretary
United States Department of Housing and Urban Development
451 7th Street S.W.
Washington, DC 20410

Dear Secretary Donovan:

I am writing to express my support of SCAPE's Living Breakwater, a Rebuild by Design initiative that will help protect Staten Island from future storms, enhance ecology, and connect residents and students to our shoreline. The people of Staten Island suffered devastating and tragic losses as a result of Hurricane Sandy. For the south shore, the storm also carried away up to thirty feet of waterfront land. Despite the efforts of the City and the State to stem this erosion, the shoreline continues to crumble, leaving homes, parkland, and businesses exposed to future storms.

The Rebuild by Design proposal by SCAPE and partners identifies an innovative and important means of stemming these losses. Their living breakwaters would reduce the destructive force of waves, preventing erosion of the beaches and bluffs that protect the community for storms. These reef-like structures are specially designed to enhance coastal ecology, important for both the fish and the commercial and recreational businesses that depend on healthy fisheries for their livelihood. The SCAPE team has also made the community a critical element in the program, in particular by proposing a way to reconnect the shoreline's restoration to Staten Island's rich maritime heritage and in particular the lives of secondary school students.

As a marine scientist and active member of the new Science and Resilience Institute at Jamaica Bay, I am particularly excited to see such innovative solutions to coastal resiliency being proposed. If SCAPE's project is selected, it would present a unique opportunity to advance our understanding of how to protect our coastal communities in an era of sea level rise. Not only would this project protect communities, but it would also attract researchers and graduate students from around the region interested in advancing the science of resilience.

Thank you for your leadership of the President's Task Force and on continuing to push for innovative ways of integrating Sandy recovery and rebuilding with community needs. The SCAPE project has delivered on that goal. We urge you to find the means to continue to advance this important proposal.

Sincerely,

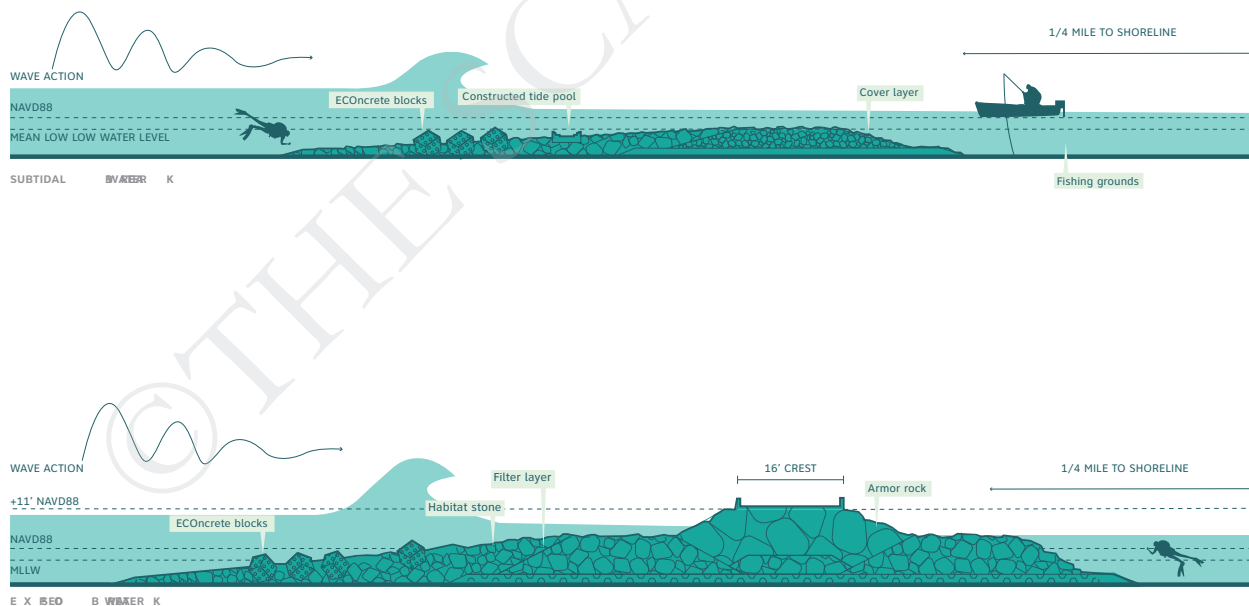
Brett F. Branco, Ph.D.

Department of Earth and Environmental Sciences

Brooklyn College of The City University of New York
2900 Bedford Avenue • Brooklyn, New York 11210-2889 • Telephone (718) 951-5631

A TECHNICAL SOLUTION

The team has crafted an innovative and yet feasible solution to address a threefold need to reduce risk, grow ecological resiliency, and build social resiliency. The design has been informed by technical experts including engineers and ecologists, and the input and analysis from these experts is reflected in the level of technical detail presented in the design. The team has undertaken extensive analysis, including hydrologic modeling, in order to craft a design that maximizes the positive risk reduction and ecological and social impacts of the design. The team has also identified those areas where more information is needed and outlined the specific additional studies and modeling needed to develop and adapt the design to be ready for construction.

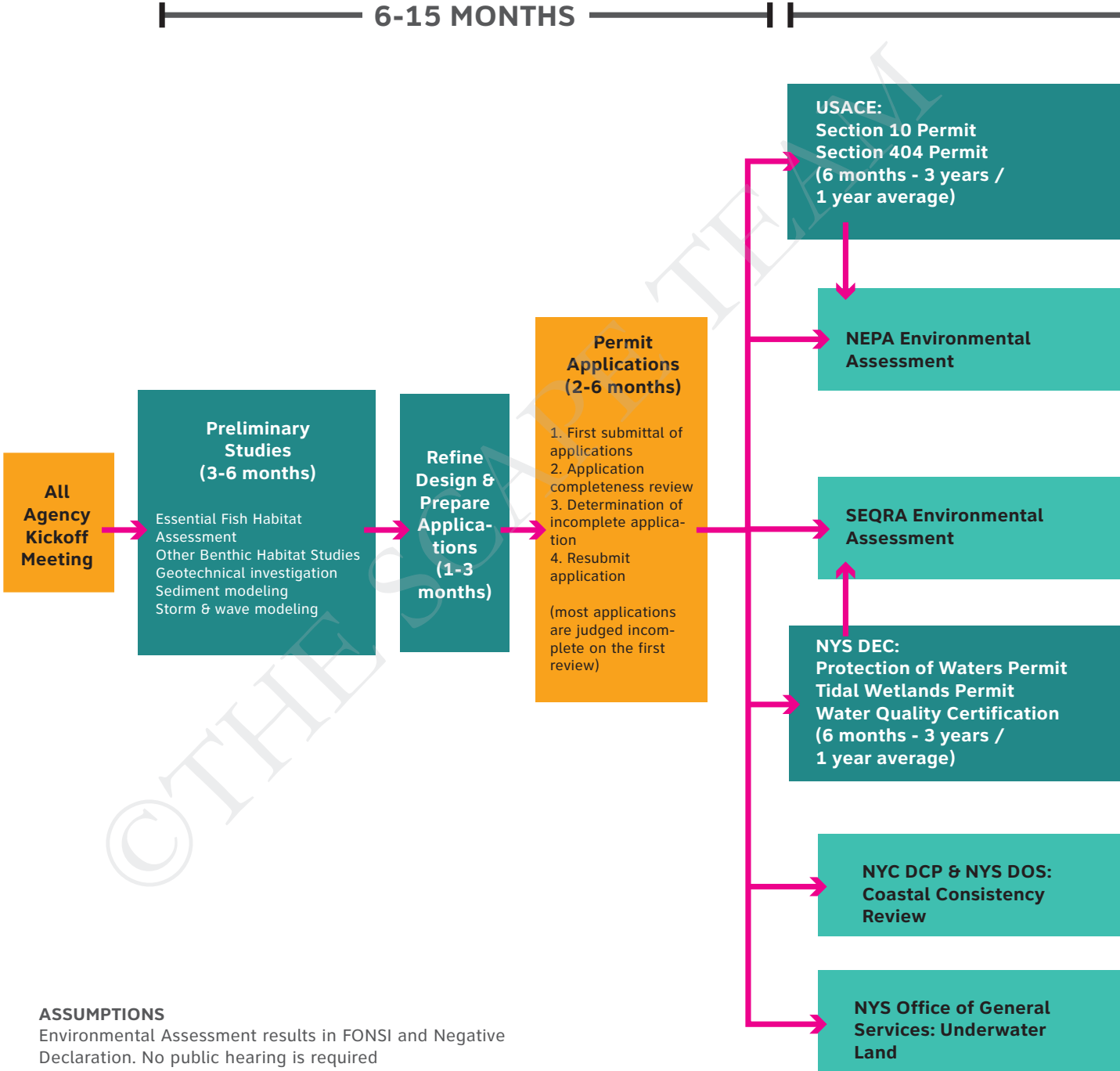


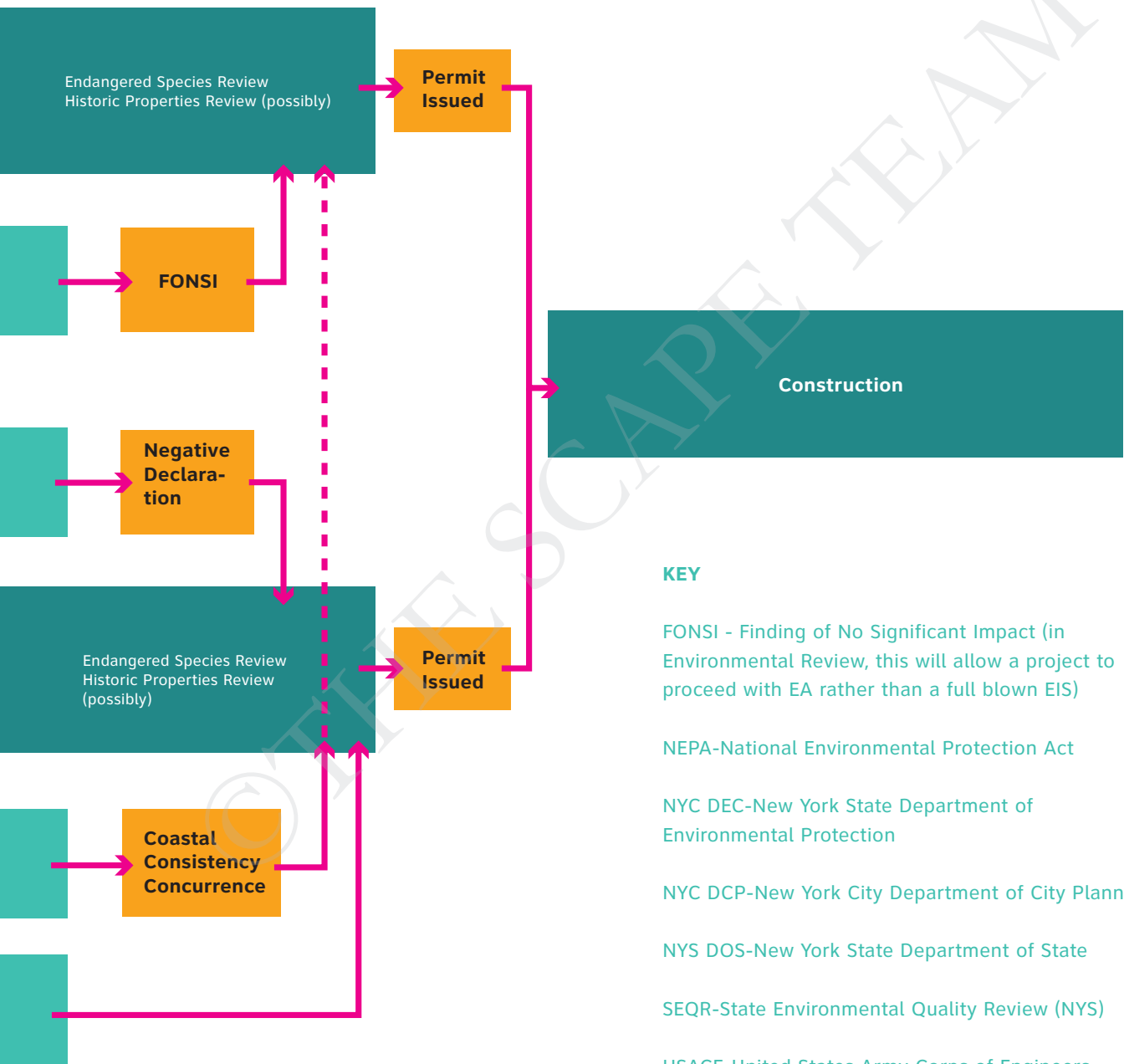
A ROBUST REGULATORY STRATEGY

The team has met multiple times throughout this process with potential project implementation partners and regulatory agencies. The input from these potential regulators has informed both the project design and approach to implementation. The team has mapped out a regulatory pathway that will advance the project from the culmination of the RBD Phase III to construction and has identified the reviews, approvals, and permits that will be required for the implementation of this project. In addition, we have identified potential hurdles to implementation and specific strategies to overcome them.

1. **AVOID BARRIERS** Identify the barriers to implementation and avoid them as much as possible, either by changing location or minimizing temporary impacts with actions like seasonal work windows.
2. **EARLY AND FREQUENT COORDINATION WITH REGULATORY AGENCIES AND STAKEHOLDER ORGANIZATIONS** to educate them about the project, understand their concerns, and learn how to avoid or minimize impacts that are important to these groups. This action also includes getting commitments from senior leadership in these groups.
3. **LINK THE PROJECT INTO AN APPROVED REGIONAL FRAMEWORK**, either using regional shore protection plans and/or ecosystem improvement plans such as The Hudson Raritan Estuary Comprehensive Restoration Plan (HRE CRP).
4. **CLOSE DATA GAPS** Regulatory and advisory agencies lack the resources to obtain all the data that is important for their review processes; without sufficient data they are more inclined to delay projects with additional data requests. For this reason filling data gaps (within reason) early in the permit process and/or making commitments for follow-on studies will avoid delay.
5. **ENSURE THAT THE PROJECT IS CONSISTENT WITH AGENCY REVIEW STANDARDS FOR ISSUING A PERMIT** (these standards are generally applicable for all the regulatory agencies):
 - a. the proposal is reasonable and necessary (this is achieved by demonstrating the benefits of the project)
 - b. the proposal will not endanger the health, safety and welfare of the people of the State of New York
 - c. the proposal will not cause unreasonable, uncontrolled, or unnecessary damage to the natural resources of the state including soil, forests, water, fish, and aquatic and related environment (in other words the project must be compatible with the preservation, protection, and enhancement of the present and potential values of the water resources).
6. **CONTINUE TO STRESS THE PROJECT BENEFITS OF PROTECTING THE PUBLIC HEALTH AND WELFARE** by noting the loss of life and property/infrastructure damage from past storms and showing what the project will do to avoid/reduce this damage.
7. **USE CASE STUDIES** Avoid unnecessary or duplicative work by utilizing applicable case studies like the USACE's Plumb Beach Beneficial Use of Dredge Materials for Shoreline Protection and others.
8. **CONTINUE COMMUNITY OUTREACH** Outreach is important for early identification of community issues and ways to address those issues as well as garnering public support (both public support – as indicated by positive comments from community groups and representatives – and a lack of public objections will avoid regulatory delays).

PILOT PROJECT REGULATORY PATHWAY





KEY

FONSI - Finding of No Significant Impact (in Environmental Review, this will allow a project to proceed with EA rather than a full blown EIS)

NEPA-National Environmental Protection Act

NYC DEC-New York State Department of Environmental Protection

NYC DCP-New York City Department of City Planning

NYS DOS-New York State Department of State

SEQR-State Environmental Quality Review (NYS)

USACE-United States Army Corps of Engineers

STRONG FUNDING JUSTIFICATION

Identifying funding sources is key, but in order to access these sources, clear justification for the expense of funds expressed in terms of the goals and objectives of the particular funding source are required. The team has developed and applied a method for estimating the impacts of the project on reducing land loss to erosion, damage to property, and loss of life. For the proposed pilot phase at

Tottenville, these risk reduction benefits considering a 100 year storm event were monetized and compared against the cost of the project yielding a benefit cost ratio greater than 1 and indicating that even without consideration of the additional ecological, social, and economic benefits offered by the project, the benefits to risk reduction outweigh the cost of implementing the Tottenville pilot.

TOTTENVILLE PILOT: RISK REDUCTION*

RISK REDUCTION BENEFITS (Loss/Damage Avoided)

COSTS

	Loss/damages Without Project	Loss/damages With Project	Benefits (difference)
Residential			
Reconstruction	\$52,073,000	\$19,405,750	\$32,667,250
Relocation	\$26,151,984	\$0	\$26,151,984
Commercial			
Reconstruction	\$1,248,000	\$166,250	\$1,081,750
Revenue	\$20,000,000	\$0	\$20,000,000
Roads			
Reconstruction	\$5,815,007	\$3,251,829	\$2,563,178
Parks & Beaches			
Reconstruction	\$266,764,016	\$127,316,309	\$139,447,707
Safety			
Loss of Life	\$13,063,484	\$0	\$13,063,484
Property Values			
Value Lost	\$2,772,608	\$0	\$2,772,608
Erosion Control Costs	\$17,062,500	\$0	\$17,062,500
Storm Year Impacts	\$387,888,100	\$150,140,138	\$237,747,961
Effective Annual Impact	\$4,049,506	\$1,501,401	\$2,548,105

Assumptions:

Effective Life of Project	100 years
Discount Rate	5%

Escalation rates revised based on USACE ratios provided by Scott Davis at HUD. The assumption made for cost escalation was: escalation over a four year permitting and construction period from 3QFY2014 to 3QFY2018. The escalation rate used for capital construction and equipment was 8%. No escalation was applied to programming, monitoring, or maintenance and operations costs. As these will be pilot projects/the first of their type, the soft costs may require additional iterations of design and

modeling. These are approximately 5% of the total breakwater costs.

Living Breakwaters is part of a greater strategy of resiliency along the South Shore of Staten Island, a layered approach which builds on the ongoing planning and construction of other organizations, including the State NY Rising program. While none of these costs are included in the cost analysis of for Living Breakwaters, the coordinated implementation of these measures is key to a successful project.

TOTAL COST TOTTEVILLE REACH	
Total Capital Construction Costs	\$58,473,000
Total Equipment Costs	\$632,000
Total Programming costs (period varies)	\$1,902,000
Total Maintenance Costs (period varies)	\$11,697,000
Total Monitoring costs (period varies)	\$1,200,000
TOTAL COSTS (undiscounted)	\$73,904,000

BENEFIT-COST ANALYSIS

Discounted Analysis (@ 5%)

Total Benefits	\$81,862,645
Total Costs	\$51,373,952
BC Ratio	1.59
NPV	\$30,488,693

Sensitivity Analysis (@ 5%)

15% Increase in Benefits

Benefits	\$94,142,041
BC Ratio	1.83
NPV	\$42,768,090

15% Decrease in Benefits

Benefits	\$69,583,248
BC Ratio	1.35
NPV	\$18,209,296

15% Increase in Costs

Costs	\$59,080,044
BC Ratio	1.39
NPV	\$22,782,600

15% Decrease in Costs

Costs	\$43,667,859
BC Ratio	1.87
NPV	\$38,194,786

*** THIS BENEFIT-COST ANALYSIS REFLECTS RISK REDUCTION BENEFITS ONLY AND DOES NOT INCORPORATE ECOLOGICAL OR SOCIAL BENEFITS. SEE TECHNICAL APPENDIX FOR DETAILS.**

LIVING BREAKWATERS

SOUTH SHORE OF STATEN ISLAND



Tottenville—"The town the oyster built"—was founded on a thriving oyster economy and a rich maritime industry.

BOP's Oyster Gardening Manual will provide information how to actively engage students with oyster restoration in Raritan Bay.

Public School 1

Intermediate School 34

Tottenville

Historically, the South Shore had a vibrant shoreline culture. Encouraging recreation and education will help to rekindle this historical linkage to the water.

Linking initiatives underway at Conference House Park to the larger breakwater system is key for efficient coastal protection in the future.

Coastal maritime forest restoration

Protective dune

Kayak fishing zone

Intertidal breakwaters

Subtidal constructed reefs

Active oyster restoration and monitoring

Underwater scuba trail

Marinas hold the potential to cultivate educational opportunities as well as economic gains for the South Shore as valuable water access points.



Great Kills Harbor

Eltingville

Crescent Beach water hub



Annadale



Huguenot

Tottenville High School

Prince's Bay

Spat sanctuary

Lemon Creek water hub

Sherrill's Pier



Our community outreach events engaged the entire island. Here, Staten Islanders built an interactive oyster reef for future educational events, and teachers discussed the potentials of the Billion Oyster Project curriculum.



Staten Island clammers actively helped to shape and inform the placement of the breakwaters to avoid critical shellfish habitat.

Living shoreline

Tottenville water hub

Exposed breakwaters

Enhanced fishing grounds

Navigation channel

Biogenic buildup of marine species creates a thriving ecosystem and serves to structurally reinforce the breakwaters.



Eastern oysters were harvested by hand from native beds in Raritan Bay. Oyster leases were created and farmed until the late 1890s.

The SCAPE team has developed a science-driven methodology that pairs layered eco-infrastructural systems sited for risk-reduction with social and educational networks, rebuilding water based infrastructures in tandem with surrounding communities.

Our project for Staten Island, NY - called Living Breakwaters **REDUCES RISK, REVIVES ECOLOGIES, AND CONNECTS EDUCATORS TO THE SHORELINE**, inspiring a new generation of harbor stewards and a more resilient region over time.

**BUILDING SOCIAL
RESILIENCY**



**REDUCING
RISK**



**GROWING
ECOLOGICAL
RESILIENCY**

